ARCTIC ALASKA AND ICEBREAKING: AN ASSESSMENT OF FUTURE REQUIREMENTS FOR THE UNITED STATES COAST GUARD

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THESIS

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An Assessment of Future Requirements
for the United States Coast Guard

by

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by

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Lieutenant, United States Coast Guard
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Submitted in partial fulfillment of the
requirements for the degree of

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INTRODUCTION

The arctic, long a domain reserved for the natural world and a scattering of awesomely-adaptive aboriginal people, now faces the assault of rational man and the effects of his civilization. It is quickly becoming a part of the "real" political and economic world. The process began several centuries ago and is in many ways analogous to the quest for treasure that lured colonizing Europeans to the far corners of world. Hydrocarbon energy is the arctic's principal treasure; and technology, the economics of demand and political events in an increasingly interdependent world have converged to make it irresistible. The region's inhospitality is no longer an adequate defense. One of the last frontiers is yielding.

But the arctic may be conquered in a different way. There is a new and powerful concern for the untrammelled environment, and especially so in Alaska. This countervailing force to indiscriminate development was born about the time that the Prudhoe Bay oil discoveries were announced in 1968, and had an important effect on shaping that first episode of resource development. Environmental concern will probably have a significant role in shaping the course of future events as well.

What happens in arctic Alaska will have significant impact throughout American society, from the residents of

that unique state to the consumers and end-users of petroleum products. There will also be important consequences for governmental agencies. The U. S. Coast Guard has particular responsibilities for marine transportation, and has accumulated extensive organizational expertise in ice-covered waters.

Icebreaking is both old and new. Men have navigated gingerly through ice-strewn waters for centuries; somewhat more recently they began strengthening their ships to withstand the forces of ice. The modern icebreaker, however, developed only in this century and has made access to the polar frontiers relatively routine. Icebreaking capability, by making arctic marine transportation feasible, is one of the technological factors which enables arctic development. Similarly, development of natural resources in arctic Alaska, however it ultimately unfolds, will inevitably make demands on the Coast Guard's icebreaking responsibilities.

The long lead time in planning for adequate icebreaking resources requires a view forward. By examining the past and events now in motion, it may be possible to glimpse the shape of future requirements. More usefully, perhaps, issues can be clarified and areas for policy decisions can be accentuated. Looking into the future and attempting to identify what may be there is a hazardous undertaking. But not looking ahead, toward the inevitable changes, probably involves even more risk.

I. BACKGROUND: ICEBREAKING AND THE COAST GUARD

The Coast Guard is in certain ways unique in the country's governmental structure. It is, by definition, an armed force of the United States yet virtually the entire thrust of its peacetime role is distinctly non-military. This dual nature is characteristic of individual operating units as well as the organization as a whole. The sheer scope of duties is also noteworthy; there are fourteen operating programs (or major endeavors) carried out by 38,400 uniformed personnel, 5,400 civilian employees, 11,700 selected reservists and an auxiliary of 42,500 [Reference 160]. The Coast Guard has been descriptively categorized with regard to these features as a dual-role, multi-mission agency: it is a military service performing a wide range of civilian duties [Ref. 2].

A. OBJECTIVES AND OPERATING PROGRAMS OF THE COAST GUARD

The Coast Guard's purpose as an organization stems from seven formal objectives (designated by letters). The operating programs are defined in terms of specific action and resource allocation plans designed to achieve the objectives. Formal objectives are as follows:

--Objective A - to minimize loss of life, personal injury, and property damage on, over and under the high seas and waters subject to U. S. jurisdiction.

--Objective B - to facilitate transportation with particular emphasis on waterborne activity in support of national economic, defense and social needs.

--Objective C - to maintain an effective, ready armed force prepared for and immediately responsive to specific tasks in time of war or emergency.

--Objective D - to assure the safety and security of vessels and of ports and waterways and their related shoreside facilities.

--Objective E - to enforce federal laws and international agreements on and under waters subject to the jurisdiction of the U. S. and under the high seas where authorized.

--Objective F - to maintain or improve the quality of the marine environment.

--Objective G - to cooperate with other governmental agencies and entities (federal, state and local) to assure efficient utilization of public resources, and to carry out activities in the international sphere where appropriate in furthering national policy.

The single factor which most nearly embraces the Coast Guard's multitudinous responsibilities is involvement with the sea and maritime affairs. This especially applies to inland waters and coastal areas, but modern responsibilities also encompass large ocean expanses as well. A slightly more restrictive generalization is the service's involvement with marine transportation, which is reflected by its position in the Department of Transportation. The maritime orientation with a transportation focus is part of a historic legacy, dating from Alexander Hamilton's creation of the Revenue Marine in 1790; prior to 1967 the Coast Guard was part of the Treasury Department, reflecting its origin as a revenue collection and smuggling suppression service. A hundred and

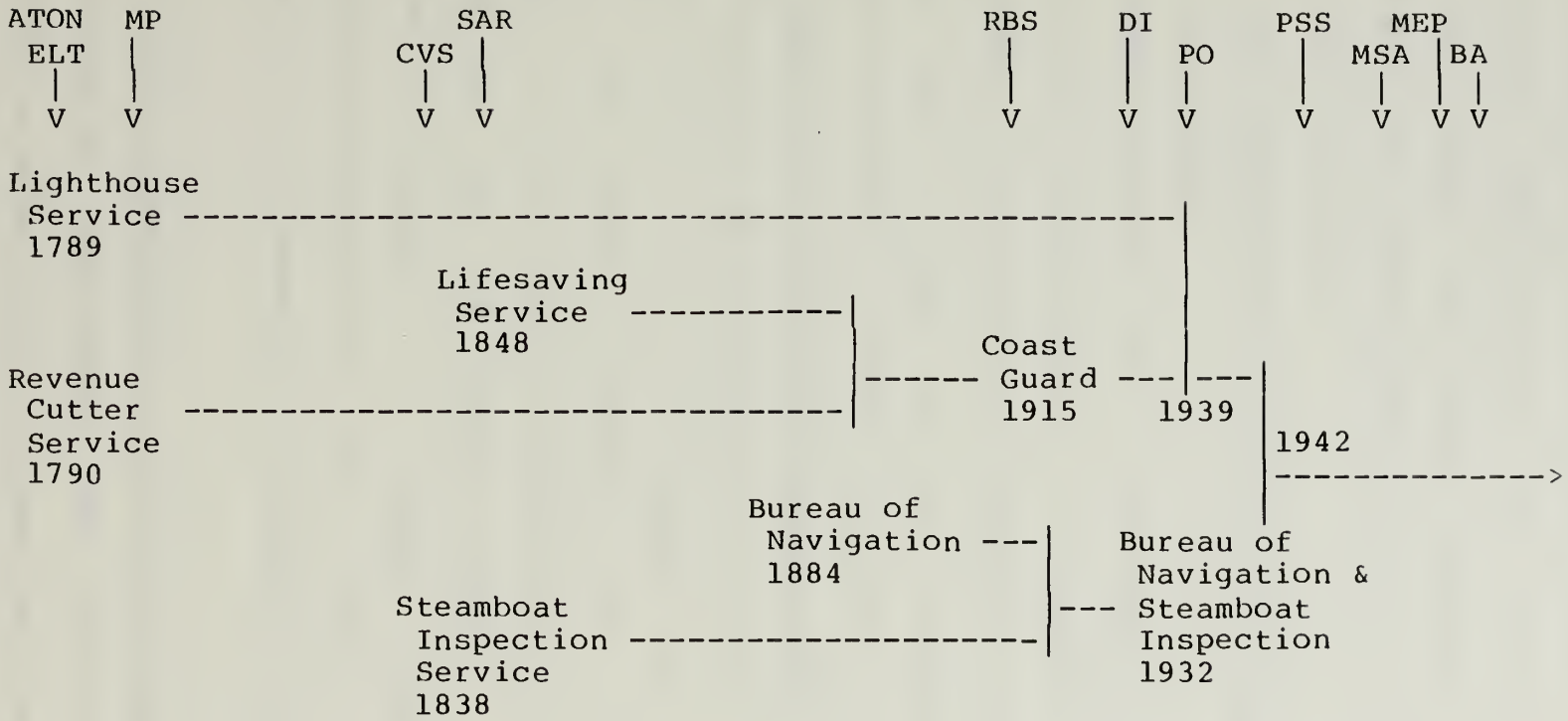


Figure 1-1: Organizational Evolution of the U. S. Coast Guard
[Reference 149]

ninety-one years of organizational mergers and acquisition (in some cases, imposition) of new tasks has evolved into today's Coast Guard. The fourteen operating programs that execute the broad responsibilities of the organization are briefly described below.

1. Short-Range Aids To Navigation and Radionavigation Aids (ATON)

Facilitation of safe and expeditious passage of marine traffic is the purpose of a system of over 47,000 buoys, lights, radio beacons and daymarks, and numerous Loran and Omega stations which provide far-reaching continuous electronic navigation for ships and aircraft [Ref. 38].

2. Enforcement of Laws and Treaties (ELT)

Protection and preservation of natural resources and national interests in U. S. territorial and adjacent waters is one of the oldest functions but is particularly significant since the country established a 200-mile economic management zone for its coastal waters. The program encompasses surveillance of foreign fishing fleets, suppression of smuggling and other illegal activities and enforcement of environmental protection regulations [Ref. 38].

3. Military Preparedness and Military Operations (MP/MO)

By law the Coast Guard must maintain itself as a ready, effective armed force, prepared for specific tasks in time of war or national emergency. Coast Guard units operate

with the Navy to train and support some naval operations. The service is transferred to the Navy Department at the direction of the President for wartime utilization [Ref. 38].

4. Commercial Vessel Safety (CVS)

In order to prevent injury and death, property loss, and environmental damage, the Coast Guard administers regulations governing commercial vessels and oil rigs. Safety standards are implemented through vessel and equipment inspection, vessel documentation, licensing of seamen and investigation of accidents and violations [Ref. 38].

5. Search and Rescue (SAR)

Perhaps the most glamorous of the operating programs, the assistance of persons and property in distress extends to U. S. jurisdictional waters, the Caribbean Sea, and most of the North Pacific and North Atlantic Oceans. An estimated 4300 lives and $268 million in property were saved in 1973 [Ref. 38].

6. Recreational Boating Safety (RBS)

This program seeks to minimize the loss of life and property associated with recreational boating. Safety patrols are conducted, liaison with state and local agencies is maintained, equipment is approved for manufacture, and educational programs for the boater are promoted. The Coast Guard Auxiliary, a volunteer organization sponsored by the Coast Guard, provides valuable assistance in this functional area [Ref. 38].

7. Domestic and Polar Icebreaking (DI, PO)

These programs are discussed in subsequent sections of this chapter.

8. Port Safety and Security (PSS)

To reduce the risk of marine accidents, the Coast Guard monitors activity in ports and harbors and enforces a variety of laws and safety regulations. This involves supervision of vessels loading, carrying and discharging hazardous cargoes, investigation of accidents and violations, and managing traffic flows. The establishment of vessel traffic systems is the newest development [Ref. 38].

9. Marine Science Activities (MSA)

Oceanographic and meteorological activities are conducted to support national marine science objectives and other Coast Guard programs. This includes data collection, conducting the International Ice Patrol in the North Atlantic and supporting scientific research efforts [Ref. 38].

10. Marine Environmental Protection (MEP)

In order to prevent and minimize damage to the marine environment, the Coast Guard enforces laws and regulations in this area, maintains surveillance of coastal waters, administers a system of enforcement and maintains a cleanup capability. Pollution by petroleum products is especially significant and a continuing concern of the program. [Ref. 38].

11. Bridge Administration (BA)

Bridges crossing waterways are frequently impediments to the passage of marine traffic. The Coast Guard inspects bridges, issues permits to insure that marine needs are met, promulgates regulations for drawbridges, and supervises modifications to bridges creating undue obstructions [Ref. 38].

12. Support Programs

Support of the operating programs is provided by communications, public affairs, research and development, personnel, civil rights, legal, engineering, fiscal and supply, health care, and intelligence/security programs.

As key elements in an overall planning and budgetary process, these programs are managed by program managers and directors on the staff of the Commandant of the Coast Guard. The programs are carried out by operating units in the field. Figure 1-2 shows the basic organizational structure. The Chief, Office of Operations is program director, and the head of his Marine Science and Ice Operations Division is program manager for the polar and domestic icebreaking programs. This thesis will deal, for the most part, with the icebreaking programs.

B. DEVELOPMENT OF THE ICEBREAKING MISSION

The earliest applications of icebreaking in this country date from 1837 when municipal efforts in Baltimore,

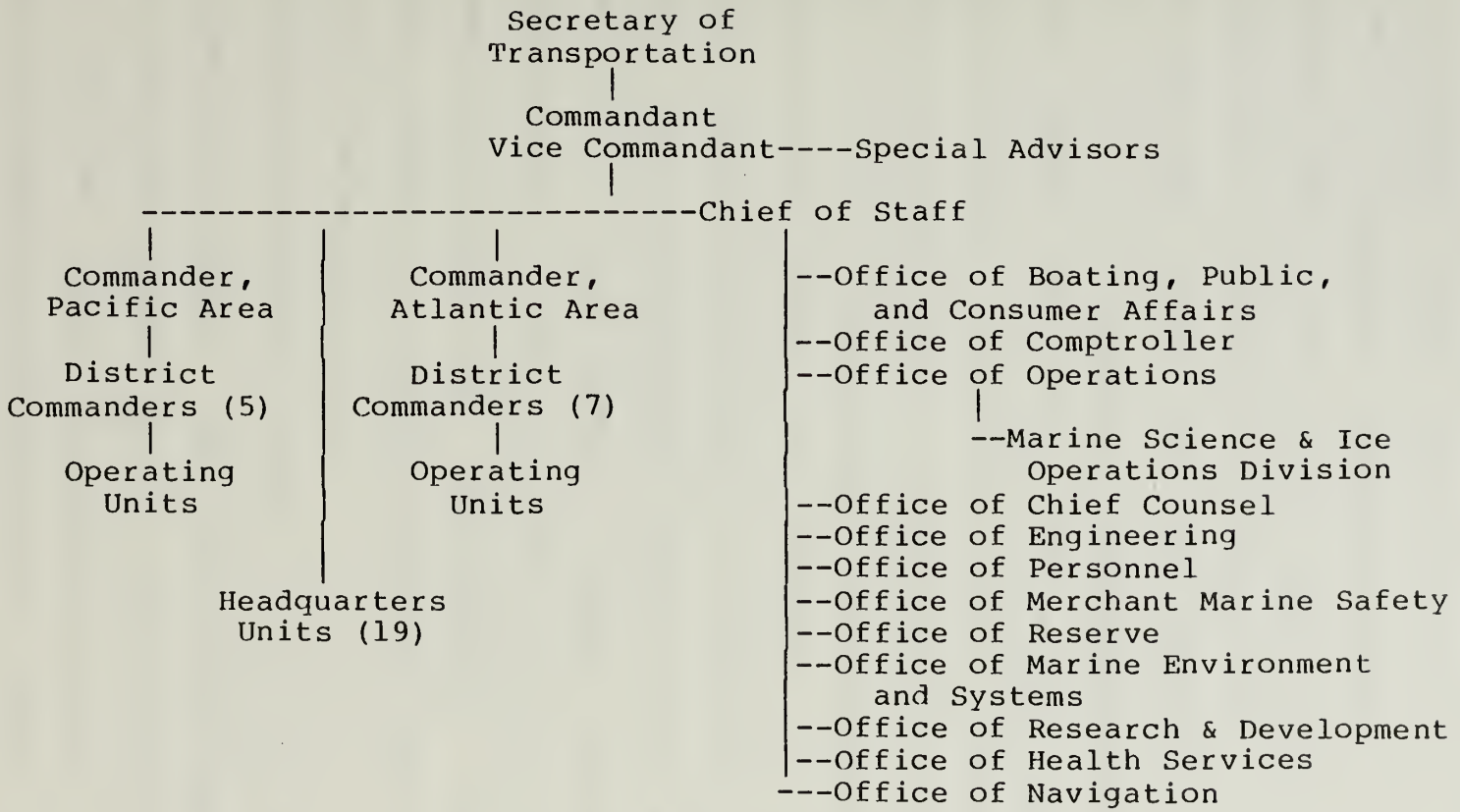


Figure 1-2: U. S. Coast Guard Organization
[Reference 149]

Philadelphia, New York and Boston sought to keep these ports open for commerce. Paddle wheel ferryboats with "ram" bows were used for the purpose. Also in response to the demands of commerce, Great Lakes ferries began breaking ice in the late 1880s with a high degree of success [Ref. 1].

The same time period saw the beginnings of American interest in the polar regions. Sealers and whalers ventured into these unknown areas from the earliest days of North American settlement; Nathaniel Palmer discovered the antarctic continent's Palmer Peninsula while sealing in 1820. In 1838 Lieutenant Charles Wilkes led a six-ship U. S. Navy expedition to the antarctic for research and exploration. The arctic became a prime concern in 1867 with the purchase of Alaska, and ice-strengthened revenue cutters were procured for operation in Alaskan waters. Regular cruising in the Arctic Ocean began in 1880, and a four-ship Bering Sea Patrol Force was instituted in 1895. The legendary revenue cutter BEAR was a fixture of Alaskan arctic and sub-arctic waters for 41 years during this period.

Following the TITANIC disaster in 1912, the United States established an ice patrol. This undertaking became an international one, and research efforts led to operations in the eastern arctic and along the Greenland coast [Ref. 42]. Although technically not a precursor of modern icebreaking, the Coast Guard gained extensive organizational expertise which built on long involvement in the western arctic.

Admiral Richard E. Byrd's antarctic expeditions in the 1930s represented a continuation of U. S. interest in the high southern latitudes. The BEAR, retired as a revenue cutter, was Byrd's headquarters ship during his antarctic exploits.

Domestic icebreaking was directly assigned to the Coast Guard by Executive Order 7521 of December 21, 1936. It directed the service to "assist in keeping open to navigation by means of icebreaking operations . . . channels and harbors within the reasonable demands of commerce" [Ref. 42]. This was perhaps most significantly applicable on the Great Lakes immediately prior to World War II, where the defense effort led to the Coast Guard charter of ferries for icebreaking operations. The MACKINAW was specifically constructed for the Lakes to expedite movement of iron ore. A number of ice-reinforced buoy tenders were also built during the war for added ice capability on these inland waters.

The Second World War brought with it development of the first deep-draft, modern American icebreakers, thanks largely to the foresight of Admiral Russell R. Waesche, the Coast Guard's wartime Commandant [Ref. 13]. A comprehensive review of the icebreaking problem and state-of-the-art icebreaker design in Europe had been undertaken in 1937, and from this study, the venerable WIND-class design was developed [Ref. 13]. Seven of these ships were produced. EASTWIND was commissioned in 1944 and saw service as a Coast Guard-manned

vessel, along with many others in Greenland during the war. Three icebreakers of the class were transferred to the Soviet Union for wartime use (although the ships were not returned until 1951). The final three were built at the end of the war, with one assigned to the Coast Guard and two becoming Navy vessels. STORIS, a smaller and less powerful ice-capable ship, was built in 1942 for use in the Greenland-Labrador arena [Ref. 42].

The WIND-class has served as an enduring prototype for the "modern" icebreaker. It is characterized by a heavily strengthened underwater hull (1 7/8 inches thick fore and aft), deep draft (29 feet), large beam, a bow which slopes aft and downward from the waterline, and ample power. An icebreaker functions by steaming continuously through relatively light ice, or backing and ramming in heavier accumulations. In both cases the vessel uses its power and weight to displace the ice; in backing and ramming the icebreaker is driven up onto its sloping bow until the weight of the vessel breaks the ice and shoves it to each side. Although many refinements in bow design, propulsion systems and sheer power and size have been made over the years, the basic concepts built into the WIND-class have survived. It is worthy of note that two of these ships are still in service.

The post-war years brought expanded roles for the expanded capabilities of the icebreakers. The massive

Operation Highjump (1946- 47) involved use of naval and air support for scientific operations in Antarctica, and the Navy and Coast Guard icebreakers played a central role. Construction of arctic defense early warning (DEW-Line) stations during the cold war years required icebreaker support as well, mainly for logistic purposes. A number of routine annual missions for the icebreaker fleet evolved.

In 1965 the Coast Guard became the sole proprietor of U. S. icebreakers. A memorandum of agreement transferred all five Navy icebreakers to the Coast Guard; the move reflected the Navy's desire to utilize its personnel in combatant vessels, and perceived advantages of centralizing management of the resources. The agreement delineated that the ships would retain their commitment to support naval operations, including preparation for war in the high latitudes, and would serve under Navy operational control when necessary. The mission of the icebreakers was defined: "To ensure passage of ships through ice fields and sea ice in support of bases and operations in high latitudes." Eight more detailed tasks were also specified, including ice reconnaissance, scientific operations, logistic support, diving, salvage, underwater repair and as a command platform [Ref. 173].

C. CURRENT POLAR INVOLVEMENT AND POLICY

As the icebreaking mission has developed, it has traditionally been separated into domestic and polar modes

and, up until the present time, this division has been fairly explicit. Differentiation of the two forms is focused, as the terms imply, on their geographic application, but an additional distinction has evolved. Both involve assistance to "users" of icebreaking services. In domestic areas this has generally meant commercial shipping, while high latitude clients have been other governmental agencies and institutions. This destinction has its basis in the fact that the polar regions have traditionally been prime areas for research and, until recently, were irrelevant for commercial purposes.

1. Icebreaking at the Ends of the Earth

Requirements of user organizations have involved logistic support, scientific research, assistance to vessels in the ice and the contingent possibility of supporting military (especially naval) operations. As Figure 1-3 shows, some of these requirements have other objectives further downstream. There are some minor functions generated solely by Coast Guard missions, such as marine science, search and rescue, and aids to navigation work, but the bulk of polar icebreaking has been a response to the needs of client organizations.

The contractual implication in a client-icebreaker relationship is descriptive, because memoranda of agreement have been signed in some cases. At the behest of the Office

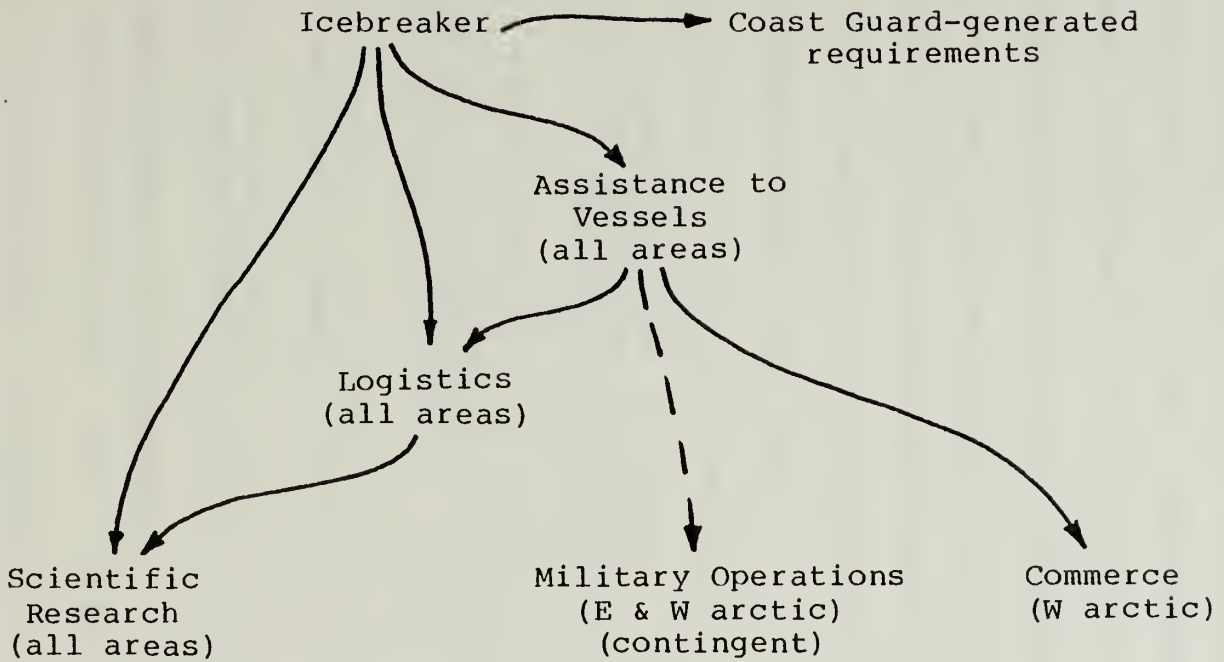


Figure 1-3: A Hierarchy of Polar Icebreaking Functions

of Management and Budget (OMB), the National Science Foundation (NSF) became responsible for directing the U. S. Antarctic Program in 1971, and the Coast Guard effectively became a "contractor" providing icebreaking services. The contractual nature of the relationship was further strengthened by Congressional direction in the fiscal year 1976 appropriation bill that polar icebreaking services for major users (identified as NSF and the Department of Defense) be provided on a reimbursable basis [Ref. 167]. Memoranda of agreement with these agencies specify criteria for planning and reimbursement [Refs. 170, 171].

In recurrent functional terms, polar icebreakers

--annually break a channel into Antarctica's McMurdo Sound and assist the passage of a freighter and oiler for provisioning the large U. S. station there.

--embark scientific parties for a variety of research, under the aegis of NSF, National Oceanic and Atmospheric Administration (NOAA), Office of Naval Research, or Naval Oceanographic Office.

--assist in the resupply of arctic DEW-Line bases and remote antarctic research stations.

--engage in trafficability studies, gathering data of icebreaker performance in various ice environments.

2. Icebreaking on the Homefront

Domestic operations have been defined as those conducted on the east coast from Maine to the Chesapeake Bay, throughout the Great Lakes, on the upper Mississippi River system, and in Alaskan waterways except along the northern shore [Ref. 42]. The domestic Alaskan tasks have

historically involved assisting vessels to reach Anchorage through Cook Inlet, and occasional clearing of small boat harbors in exceptional conditions [Ref. 42].

The level of commercial support has long been controversial. Shipping interests on the Great Lakes, for example, strongly support moves to extend the shipping season, even to the point of year-round navigation. This is feasible with the commitment of enough icebreakers to do the task; but the economic advantage to private concerns must be balanced with the public cost. Providing service on a reimbursable basis has been suggested, but never adopted for domestic icebreaking. The Coast Guard's current domestic icebreaking policy provides that [Ref. 159]:

--icebreaking operations will be conducted to keep open those principal waterways which are not normally closed to commerce in the winter.

--icebreaking operations will be conducted to maintain traditional commercial navigation seasons on principal waterways which are not normally open to year-round navigation.

--the Coast Guard will extend the season or attempt to provide year-round navigation where benefit/cost studies indicate that it is in the national interest.

--the Coast Guard may provide icebreaking services when requested by the Corps of Engineers to aid in the prevention of flooding caused by ice jams.

--any icebreaking required in the pursuit of search and rescue missions will be conducted.

--the Coast Guard will not normally compete or provide service when commercial icebreaking service is available.

Domestic policy is significant to arctic Alaska because the two modes are beginning to merge in this area. Even though it is U. S. territory and waters, arctic Alaska is a polar region and has been virtually devoid of commercial marine traffic. The latter feature has begun to change. As private enterprises have moved into the picture, the Coast Guard has assisted barge convoys pushing through to Prudhoe Bay. With the possibility of huge increases in marine traffic, the service faces some thorny policy issues on the employment of its shrinking icebreaker fleet. These issues will be pursued in later chapters.

D. CURRENT ICEBREAKER RESOURCES

The Second World War left the country with ample icebreaker resources relative to what had been available in the pre-war era. The deep-draft fleet consisted of seven WIND-class ships and MACKINAW, with STORIS and a number of ice-strengthened buoy tenders providing additional capability. The Navy commissioned GLACIER in 1955. As discussed previously, these ships found a number of missions supporting various activities in the polar regions and on domestic waterways; there had been little need for acquisitions or decommisssionings when the Coast Guard became the nation`s sole icebreaker operator in 1965.

As the 1960s drew to a close, it became apparent that some provision for replacing the WIND-class vessels was

needed. EASTWIND was the first of the class to retire, in 1968. In 1971, after three years of study, Lockheed Shipbuilding and Construction Company was awarded a $53 million contract to build the first of a new class of polar icebreakers. Although original plans called for four of these ships, only two were actually funded. After extensive construction delays, POLAR STAR was delivered on the last day of 1975 and was followed two years later by POLAR SEA.

The POLAR-class vessels represent an enormous increase in icebreaker performance and capability. Although 50 per cent longer than the WIND-class, the new icebreakers have twice the displacement, and the option of applying up to 60,000 continuous shaft horsepower (see Table 1-1). A "rule of thumb" measure of icebreaker effectiveness is the maximum available horsepower per ton of displacement [Ref. 14]; the POLAR-class ratio is 4.55 compared to 1.54 for the "WINDs." In an operational comparison, the WIND-class can break approximately 75 linear feet of six-foot fast ice per ram before backing for another run, while the POLAR-class can break the same ice continuously at three knots and ice up to 21 feet thick by ramming [Ref. 39].

This degree of icebreaking capability is achieved by an engineering plant of six diesel generators driving three electric motors, and three gas turbines. Power can be provided with varying engine combinations to drive the

Table 1-1: U. S. Icebreaker Resources (1981)
[Reference 11]

Ship/Class	Displacement (tons)	LOA (ft)	Draft (ft)	Air-Craft	Horse-power	Year Commissioned
2 (New)	6,247/ 7,018	296	22.8/ 24.3	2	13,500s	?
(Dual draft icebreaker for eastern arctic & US Great Lakes; class III; in final design stages)						
POLAR STAR	12,087 fl	399	31	2	18-60,000s	76
POLAR SEA	12,087 fl	399	31	2	18-60,000s	78
(Controllable pitch propellers; gas turbine or diesel electric propulsion available to each of three shafts)						
GLACIER	8,449 fl	310	29	2	21,000s	55
WESTWIND	6,515 fl	269	29	2	10,000b	43
NORTHWIND	" "	"	"	"	"	"
MACKINAW	5,253	290	19	-	10,000b	44
(Permanently committed to Great Lakes)						
STORIS	1,925 fl	230	15	-	1,800b	42
(Ice strengthened)						
9+WTGB class	662 fl	140	12.5	-	2,500b	78>
(Icebreaking tugs for Great Lakes service)						
9+WTGB class	662 fl	140	12.5	-	2,500b	78>
(Icebreaking tugs for Great Lakes service)						
8 WLB class	1,025 fl	180	13	-	1,000 or 1,200b	42-44
(Ice strengthened buoy tenders)						

Notes:
Displacement in tons; fl = full load
Horsepower indicated is brake horsepower (b) = power at crankshaft, or shaft horsepower (s) = power delivered to shaft
All vessels have been built in the United States

controllable pitch propellers. The fragility of propellers with movable blades has continually plagued the POLAR-class, and problems with this innovation have caused several polar deployments to be aborted. The propeller hubs have been subjected to extensive re-engineering. Both ships are currently considered fully available for deployment [Ref. 167].

Delays in delivery and full operational capability of the POLAR-class caused severe disruptions in icebreaker scheduling, as EDISTO, STATEN ISLAND and SOUTHWIND were decommissioned without replacement in the early 1970s. BURTON ISLAND was retained for three years beyond her scheduled decommissioning, finally passing out of service in 1978. POLAR STAR and POLAR SEA thus replaced five of the WIND-class vessels on the rationale that increased operational capability compensated for the loss in quantity.

As shown in Table 1-1, today's polar icebreaker fleet consists of five vessels, including the two newest, the aging GLACIER and two reworked WINDs. They are not under centralized command, being dispersed in homeports on the West coast (POLAR STAR and POLAR SEA in Seattle, GLACIER in Long Beach), in the Great Lakes (WESTWIND in Milwaukee), and on the eastern seaboard (NORTHWIND in Wilmington, North Carolina) under the district commander of the appropriate geographic area. STORIS is homeported in Kodiak, Alaska and ice-strengthened buoy tenders are located on the southern

Alaskan coast as well as in the continental United States.

In fiscal year 1980, the Coast Guard spent $21.4 million operating and maintaining ships and aircraft for the polar icebreaking program, of which $2.7 million was reimbursed by "user" agencies [Ref. 167]. The expense of the program has risen dramatically in recent years, as inflationary forces have pushed up fuel and personnel costs. A number of techniques have been implemented to increase ship availability and to control costs, many of which encompass quite untraditional ways of running ships. The POLAR-class was designed to operate with a crew of 140, compared to 174 and 197 for the Wind-class and GLACIER, respectively. This was achieved through automation, principally of engineroom watchstanding, and maintenance augmentation from ashore. Low maintenance construction materials and preventive maintenance systems were also features in design. The POLAR-class vessels are co-located in Seattle at a support facility which provides supply, personnel and engineering assistance.

More ship availability is a recognized means of employing the resource more efficiently. For years the Coast Guard has "piggy-backed" missions on the icebreakers, fulfilling multiple user requirements simultaneously. Many research projects are compatible, for example, with each other and with transits. Optimum geographic location of homeports, to reduce time spent in transit, has also received

consideration. Most radical is the concept of multi-crewing: the POLAR-class manning levels were set on the basis of three full crews for the two ships. This would in theory allow 270 days of ship operating time per year, with no individual crewman away from home more than 180 days. In the severe budgetary climate of the late 1970s, however, the third crew was never funded and it is suspected that the technological complexity of the vessels will not allow 270 days of operations each year [Ref. 167].

How adequate are the existing icebreaker resources? Two in-house Coast Guard studies in 1975 and 1979 estimated that icebreaker requirements in the 1981-2000 period would average 890 and 819 days per year, respectively [Refs. 37, 42]. These figures were based on surveys of the user organizations, fitting these projected requirements into feasible schedules. Both studies also concluded that these requirements cannot be met with existing resources. In addition to calculating the number of ship-days available, icebreaker scheduling is complicated by [Ref. 37]:

--concentration of user demand at certain times of the year.

--some missions which require two ships working jointly.

--the high level of vessel risk in the polar environments, making backup capability necessary.

A number of program changes are in the planning process. Budget requests for fiscal year 1982 include $10.6 million

for re-engining STORIS to upgrade her horsepower from 1800 to 4000 SHP. Her performance in 1975 North Slope tug and barge convoying was marginal, and the added power would make STORIS more effectively suited to the shallow water of Alaska's arctic coastline. Also requested for 1982 is $113.8 million for the first of two dual-draft icebreakers. These are replacement vessels for WESTWIND and NORTHWIND, and are designed to have a shallow draft for winter work in the Great Lakes and a deeper draft for summer deployments to the eastern arctic. Draft would be varied by the amount of fuel carried [Ref. 167]. Coast Guard headquarters has also completed a mission needs statement for a shallow draft icebreaker for arctic Alaska, an early step in the acquisition process [Ref. 163].

Forecasting future icebreaking requirements is a highly intuitive business. Yet the long lead time for building new vessels, the growth of important new requirements, and the austerity of the current budgetary environment necessitate decision-making far in advance of firm information. Of all the icebreaker operating areas, the eastern arctic and traditional domestic waterways appear least likely to experience the largest growth in requirements. Certainly this could be changed by policy revisions, such as year-round navigation on the Great Lakes. The antarctic seems more speculative. There is an increasing awareness of resources at the "bottom of the world," and it seems highly likely that

the United States would insist on participating in any moves to exploit them. There is nothing to indicate immediate movement, however.

Action in the arctic looms most ominously on the horizon. Events are already occurring which involve icebreaker support as well as other Coast Guard responsibilities; the STORIS rework and shallow draft icebreaker represent responses to these trends. Yet the scope of events in arctic Alaska potentially involve great changes and could ultimately have a huge impact on icebreaking. Understanding the background of this area is a first step in understanding its future.

II. BACKGROUND: ARCTIC ALASKA TO THE PRESENT

Alaska retains, in the minds of most Americans, a flavor of adventure and mystery that has been associated with the land over much of its history. The name derives either from an Aleut word, "alakshak," which refers to the mainland of the Alaska Peninsula, or is from the Eskimo meaning "great land." The latter truly befits the superlative nature of this state.

A. HISTORY

One of the thrusts of post-Renaissance Europe's outreach for treasure and exploration was the search for a Northwest Passage. Although Norse ships had earlier pushed beyond Greenland into the Labrador Sea and on to the fringes of North America, the European search for the fabled water route to the East began in earnest when Cabot sailed for Cathay in 1497. He was followed by a host of others, all unsuccessful, until Amundsen transited the ice-bound route early in this century.

Its remoteness shielded Alaska from European contact until Vitus Bering sighted Mount St. Elias and sent men ashore in 1741. As "Russian America," the vast territory was soon recognized as a rich area for whaling, sealing and fishing; lying beyond the vast expanses of Siberia, the

Russian colonizers never saw Alaska as more than a source for these commodities.

The huge territory became the last significant acquisition in a new nation's manifest destiny when the United States purchased it on October 16, 1867. The $7.2 million price made Alaska infamous as "Seward's folly" and as an icy wasteland. These complaints dissipated, however, and by the turn of the century Alaska achieved notoriety for gold and adventure by the literature of Jack London and Robert Service. Even as a possession of the United States, the territory remained, for all intents and purposes, a colony.

The Second World War brought convulsive change to Alaska. Japanese feints at Kiska and Attu, although far out in the Aleutian Chain, were answered by a large military buildup. The Alaska Highway was carved out of wilderness, creating the first all-land transportation link to the territory. In the postwar era, the military remained as Alaska's largest employer. The importance of geographic location was heightened by the cold war and brought construction of a key string of early warning stations (BMEWS and the DEW-Line) and aircraft interceptor bases.

In 1959, the Statehood Act was passed by Congress and Alaska became the forty-ninth state. There were only 211,000 residents [Ref. 8] living on the 375 million acre expanse. Alaska's history to this point can be characterized as a series of transformations, where aboriginal Alaska yielded to

colonial Alaska and then was changed by the exigencies of wartime into garrison Alaska [Ref. 22]. With the advent of colonization, the Great Land had become an area useful primarily for outside purposes: for resource exploitation and for defense of a national heartland.

Statehood dramatically altered this pattern by shifting a great deal of political control from a distant Congress to the residents themselves. Although the federal government retained title to most of the state, the Statehood Act allowed Alaska to select 103 million acres of land over the following 25 years for its own purposes. This provision was to be significant.

B. OIL AND THE NEW YUKON FEVER

Although nationally unnoticed until Atlantic Richfield Company (ARCO) announced the 1968 Prudhoe Bay strike, oil had been known to exist in Alaska for a number of decades. Early travellers noted natural seeps of oil along the arctic coast, and the first exploration on the North Slope was conducted by Standard Oil in 1921 [Ref. 18]. A large segment of northwest Alaska was designated Naval Petroleum Reserve #4 two years later by President Harding, although Navy drilling programs in 1944-53 and 1974-77 produced nothing significant [Ref. 51]. In 1957 the first oil well began flowing in Kenai, and six years later the first offshore well was sunk in Cook Inlet, beginning modest production in south central Alaska.

ARCO's announcement of the huge Prudhoe structure on July 18, 1968 did bring petroleum into the spotlight. The estimation ran to 10 billion barrels of recoverable oil; but it lay underground in an environment new to the oil industry and where advances in technology would be needed for exploitation. While drilling obstacles were significant, it rapidly became apparent that the overriding problem would be one of transporting the extracted crude oil.

Several trans-Canadian pipeline routes were proposed, to bring the oil to southern Canada where it could be funnelled into pre-existing pipeline systems. Although pipeline technology was well established, construction in the low temperatures, seasonal extremes and permafrost conditions posed formidable engineering problems. Additionally, a Canadian route would be 2400 miles in length and require the consent of a sovereign country [Refs. 54, 71].

A similar idea surfaced for a pipeline across Alaska to a suitable terminal port on the southern coast. It would be only 800 miles long, yet would necessitate a marine terminal and an extensive tanker fleet.

More exotic proposals for air cushion tanker vehicles and tanker submarines were studied [Refs. 54, 63, 83]. But one of the more interesting ideas that remained within the bounds of realistic technology and economics was a system of icebreaking tankers. This became an especially attractive alternative since the production from Prudhoe Bay was most

urgently needed on the U. S. east coast. The concept of large icebreaking tankers plying the Northwest Passage appeared to be a pragmatic solution as well as the romantic fulfillment of a centuries-old dream.

To test the feasibility of the concept, Humble Oil (now Exxon) had a 115,000 deadweight ton tanker re-engined and fitted with an icebreaking bow in a joint project with ARCO and British Petroleum. In August 1969 the 1005-foot MANHATTAN departed Philadelphia to transit the Northwest Passage and arrived at Point Barrow, Alaska a month later. Although the ship received some assistance from an accompanying Canadian icebreaker and sustained minor damage on the return trip, the overall concept was proven in a dramatic way. The costs, however, were sobering: on the basis of the vessel's performance, it was estimated that year-round operation would require 100,000 to 150,000 shaft horsepower (SHP) instead of MANHATTAN's 43,000; and the projected cost per ship was revised upward from $30 million into the $75 to 100 million range [Ref. 26].

MANHATTAN made a second trip into Baffin Bay and the eastern arctic archipelago in the spring of 1970, but the transportation mode she represented lost in the final decision process. The consortium of oil companies elected instead to build the Trans-Alaska Pipeline System (TAPS). The factors in this choice may have included:

--the absence of proven reserves in sufficient quantity to develop a new technology, including a deepwater loading terminal in the Beaufort Sea. Pipeline technology was probably felt to be closer to "state of the art" [Refs. 29, 40].

--the more uncertain economics of icebreaking tanker operation [Ref. 29].

--potentially lucrative "swap" possibilities, including shipment of Alaskan oil to Japan in return for Caribbean deliveries, which might yield more profit for the companies [Ref. 6]. None of these have materialized, since the authorizing legislation for TAPS specifically banned export of the oil.

--avoidance of the sovereignty problems that a trans-Canadian pipeline or the Northwest Passage would present; in fact, the MANHATTAN operation raised serious concern in Canada about the status of her arctic waterways [Ref. 6] (see Chapter VII).

The real reasons behind the decision can only be speculation, but its effect was immediate and intense. Coming as it did at the peak of national ecological and environmental concern, TAPS aroused significant opposition. Various analyses showed the chosen alternative to be environmentally and economically inferior to other modes [Ref. 6]. Congress acted in 1971 to settle native claims in Alaska, an issue that had been dormant for years; the Alaska Native Claims Settlement Act provided 40 million acres and $1 billion to the 43,000 natives through their membership in a system of 13 native corporations [Ref. 15]. In January of the same year, the Department of the Interior filed a preliminary assessment of ecological impact for the project, as required by the National Environmental Policy Act of 1969 [Ref. 54].

TAPS was subsequently challenged in court. The State of Alaska, the Interior Department and the oil companies were sued by an alliance of Alaska natives, fishermen, Canadian environmentalists, and American environmental groups which included the Wilderness Society, Environmental Defense Fund and Friends of the Earth [Ref. 6]. A court injunction against construction of the pipeline was granted. In March 1972, the Interior Department released an environmental impact statement and economic and security analysis of the project [Ref. 54]. After much lobbying and other legal maneuvering, TAPS received final legislative approval of the Congress in the form of the Trans-Alaska Pipeline Authorization Act of November 1973. It benefitted at the eleventh hour from the October 1973 oil embargo.

The Authorization Act did not represent a clear-cut victory for the oil companies and their development-minded allies. It was above all a piece of compromise legislation, mandating significant environmental safeguards. These included extensive baseline studies of the environment, construction techniques that would minimize wilderness and wildlife impact, and strong monitoring of construction and operation. For example, tankers carrying crude oil from the pipeline's southern terminus in Valdez were prohibited from discharging oily water at any point on their voyages; this common ballasting procedure was replaced by a water treatment plant in Valdez that processes contaminated water from

arriving ships and recovers 3000 barrels of oil per day. Water returned to Prince William Sound contains 4-6 parts per million oil, against an allowable standard of 8 ppm [Ref. 101]. The pipeline was built with sufficient overhead clearances to allow passage of reindeer herds in certain areas, and sits on refrigerated stanchions to prevent melting of the permafrost. While not satisfying the most vociferous critics, these types of safeguards produced an end result that was significantly different from what had been planned.

The construction phase had a convulsive social impact on the state. With the pressure of several years' delay and the limitations of the seasons, the builders paid exorbitant wages to attract skilled workers to the project and to keep labor peace. Uncontrolled growth of towns, skyrocketing prices, and large numbers of transients resulted. And although the pipeline greatly increased the economic base of the state, most of the boom faded when the mammoth project was finished. A future wave of development brings mixed emotions to most long time Alaskans.

TAPS was completed in May 1977, and the first barrel of Prudhoe Bay crude reached Valdez on the 28th of July [Ref. 4]. The cost of what was billed as the largest privately financed project in history had escalated from the planned $800 million to over $8 billion. The MANHATTAN, in spite of her icebreaking capabilities, now carries Prudhoe Bay oil to the U. S. west coast. The wisdom of the TAPS decision can be

called into question; and with the prospect of more petroleum development it is of more than academic interest to ask if a similar project would be undertaken again.

C. ALASKA AT THE PRESENT

Once in routine operation, TAPS has proven itself successful. At the end of 1980, 1.52 million barrels flowed through the 48-inch pipeline each day, representing some 8-10 per cent of U. S. consumption. Construction of extra pump stations could boost daily flow to two million barrels. Pump station 7 was completed at the end of 1980, adding no new throughput but eliminating the need for some expensive drag-reducing additive [Ref. 135]. The system is monitored by the Interior Department's Alaska Pipeline Office, and marine operations are regulated by the U. S. Coast Guard. The state asserts a regulatory function through the Alaska Department of Environmental Conservation. There have been minor operating problems, including small leaks and adverse winter weather precluding tanker loading, but TAPS has remained free of any major catastrophies.

The Coast Guard's role is a significant one. The Authorization Act mandated that a vessel traffic service (VTS) be established for Prince William Sound, to provide navigational assistance to TAPS tanker traffic along with a system of traffic lanes, speed limits, operating rules and radar monitoring. The effect of TAPS traffic on the pristine

and biologically abundant waters of Prince William Sound was a major concern of the environmentalists, and the Coast Guard regulatory presence addresses this issue in seeking to reduce the risk of a vessel casualty. The Marine Safety Office in Valdez provides additional on-scene capability in conducting the commercial vessel safety, port safety and marine environmental protection programs. Coast Guard involvement with TAPS is a significant precedent for oil development and transportation.

Financially, the oil flowing from Prudhoe Bay has been a bonanza for the state. Taxes and royalty revenue now register about $300 to 350 million monthly, and by November 1980 Alaska had accumulated a fund of $2 billion. Although officials have, with considerable historical irony, invested some of this in gold bullion [Ref. 88] and abolished the state income tax, this reservoir of capital will in all likelihood be used to back further development projects as well. One indication is that Alaska, along with several other states, has set up a state-financed venture capital organization. The state is also considering acquisition of a 255-foot ice-strengthened research vessel [Ref. 167].

A major undertaking now in progress is the Alaska Natural Gas Transportation System. At a projected cost now placed at $40 billion, this 4800-mile pipeline is designed to bring Prudhoe Bay natural gas through Canada to the continental U. S. It will initially move 1.1 billion cubic feet per day of

Canadian gas and when finished will supply approximately 5 per cent of U. S. gas consumption. Arrangements for the project have been complex and delicate. Federal law, for example, precluded the Prudhoe producing companies from ownership in the pipeline; the Canadians have sought reassurance that the entire system will be built before committing to their portion of it; and securing financing for such a mammoth project has been difficult. The State of Alaska may participate in building the $2.3 - 3.0 billion conditioning plant at Prudhoe Bay, and an initial contract for this facility has been let [Ref. 129]. Portions of the pipeline are now under construction. Approval has been received for 430 miles of right of way on federal land, leaving 311 miles of state, native and private land still under negotiation [Ref. 98]. It seems reasonable to say that the line will be built, but the targeted 1985 completion date seems certain to slip [Ref. 169].

Exploration for oil is imminent in a number of promising areas in Alaska, as will be discussed in Chapter IV. The heated battle over disposition and future use of huge land areas has recently reached a momentary lull; this is described in Chapter VI. The mood in Alaska can perhaps be characterized, at the risk of simplification, as generally favoring development but with stringent controls and local participation. There is, of course, a multiplicity of interests in the state. The residents of Alaska are well

aware of their enormous resource potential and its value in an energy-hungry world; but perhaps because of the past they are extremely sensitive to outside manipulation. Alaska will refuse to be merely a treasure trove, and it is in this context that future development will occur.

III. THE FUTURE AND ARCTIC ALASKA

Alaska's history of resource exploitation and the tumultous events of recent years leave the state, or at least certain portions of it, poised for a rather uncertain future. The differences in the various possibilities are large. The arctic basin may become the Persian Gulf of this era, producing a huge stream of hydrocarbons to feed the world's appetite for energy; or it may remain in a stable state with only peripheral inroads from "development." The course between these extremes that events will eventually follow is difficult to foresee. The subjectiveness of the observer and the imaginative appeal of large changes make evaluation even more elusive.

The Coast Guard will have to react to events and demands from the external environment that are perceived to fall within the scope of its responsibilities. This is the cornerstone of organizational strategy. Secondarily there must be an identification, as one text presents it, of the distinctive competence that ideally equips the Coast Guard to fill the needs. This leads to development of adequate human and physical resources [Ref. 2].

Although this age is recognized as one of accelerating change, the lead time required for organizational reaction

seems to be lengthening. Implementation of new operational systems, development of personnel expertise and acquisition of capital facilities involve structured procedure. Though it would be wrong to spring immediately to the conclusion that arctic development will require a new type of icebreaker for the Coast Guard, this situation would for example, necessitate ten years between identification of the need and commissioning of the first ship [Ref. 162]. The organization must therefore have a lengthy (and lengthening) "weather eye" for future shifts in the winds of change.

The problem then, is one of determining the future of targeted areas of interest and the Coast Guard's role in them, far enough in advance to allow action. Our rationalistic view of the world leaves us without a belief in oracles or spiritual seers; but modern thought hardly conceptualizes the occurrence of events as completely random. Trend extrapolation, scenario-writing, expert consensus techniques, and simulation and modeling all have parts to play in future study. Extrapolation of the past and present is the most common of these.

The future effect of certain trends in the arctic are reasonably clear. A primary impact on the Coast Guard's present role in arctic Alaska will be through marine transportation. This is important due to the orientation of the Coast Guard's organizational objectives and statutory responsibility, and partially to the legacy of the Alaska

Pipeline where North Slope barge convoys and tanker traffic from the terminus were the Coast Guard's main concerns. It can also be rather obviously surmised that any large-scale development in Alaska's future will be dominated by petroleum and natural gas resources. Virtually any development of these resources in the arctic regions will involve some form of marine transportation.

The brunt of Coast Guard impact will undoubtedly fall on the icebreaking program, and a number of issues are involved. Icebreaking operations in the midst of a large commercial development effort may finally dissolve any remaining distinction between domestic and polar icebreaking. Icebreaking assistance to commercial vessels on the North Slope is now placed under the domestic label [Ref. 167], and increased icebreaker involvement along these lines may reorient the program on a geographic basis rather by an arbitrary distinction between domestic and polar tasks. Reimbursement for icebreaking service is another issue lacking resolution. As discussed in Chapter I, commercial assistance has been rendered for years on traditional waterways, but it is unclear as to whether similar assistance should be expected on waters heretofore devoid of commercial activity [Ref. 164].

Assessing the impact of events is complicated by a potential overlap of programs. Search and rescue, short range aids to navigation, enforcement of laws and treaties,

marine environmental protection, port safety and security, and military preparedness/operations are all likely to have applications in future Alaskan arctic activity. In executing these functions, icebreakers will without question be utilized to a great extent, since in many arctic areas during much of the year only these ships will be capable of putting Coast Guard resources on the scene. Icebreakers may become much more multi-program units than in the recent past.

The foregoing outline touches only briefly on the future factors affecting arctic Alaska and the Coast Guard. Predicting the shape of things to come involves the examination of highly complex and contingent events. Attempts at fitting all the pieces together by intuitive means is probably beyond the rational/analytical capability of the human mind. There are simply too many separate streams of events and processes in motion to be examined in toto. Nor does the subject lend itself well to a programmed approach: only partial quantification is realistic and the relationships and contingencies are generally too nebulous to specify with mathematical precision.

One method of overcoming this problem of scale is to break the "picture" down into smaller, more comprehensible areas for closer scrutiny. The risk in doing this, however, is the same risk faced by any use of specialization: loss of overall perspective and of the essential interconnectedness

of the segments. Yet organized and thorough analysis demands some compartmentaion of the field, with careful relating of the results to compile an understanding of the whole.

The "break-down" approach represents one methodological aspect of this study. Five issues which pertain to the future of arctic Alaska and icebreaking activities have been identified from a review of literature and discussion with individuals close to unfolding events. Each of these issues will be examined in detail, with the goal of identifying the likely future by informally extrapolating trends and flavoring them with scenarios, opinions and "best guesses."

Before describing these five issues, however, a number of basic assumptions underlying the study must be restated for clarity. These include:

-- undeveloped oil and gas resources exist in arctic Alaska (including the Bering Sea) in commercially practical quantities.

--though all necessary technology is not in existence, it is within reach; and technology per se is not the most significant barrier to the future development of oil and gas reserves.

--exploitation of other minerals will remain far behind oil and gas development. The U. S. Bureau of Mines estimates 130 billion tons of coal in Alaska, ninety percent of it north of the Brooks Range [Ref. 59]. Commercial quantities of the following minerals are also believed to exist [Refs. 41, 57]:

>copper	>tungsten	>molybdenum	>silver
>fluorite	>mercury	>lead	>nickel
>tin	>antimony	>zinc	>cobalt
>platinum	>beryllium	>asbestos	

The demand for these minerals is much less than current petroleum needs, and development of the former may become economic once a functioning transportation system is in place [Ref. 40].

--other commercial ventures in arctic Alaska, such as fisheries and tourism, will remain minor compared to oil and gas efforts.

--marine transportation will play at least some role in the region's development; at the present it is the only economic means of moving large quantities of material in the arctic.

--Coast Guard objectives and programs will remain roughly in line with the status quo, with no significant additions or deletions of responsibility. The Coast Guard will therefore retain its organizational orientation toward marine-related transportation.

--as stated above, the future of arctic Alaska will have its major impact on the Coast Guard through waterborne transportation.

With these guiding assumptions, the following five issues will be examined:

1. Energy development. Perhaps the singly most important factor in arctic Alaska's future, petroleum and natural gas energy is to a large extent the fountainhead of many other "downstream" occurrences. What will transpire is, of course, far from certain. Although the country is in the midst of an almost obsessive concern for "Energy," and "energy independence" has become a catchword, there is little that could be called a national energy policy. Energy development in arctic Alaska will be influenced by a host of public policy issues, international economic factors, and foreign political events, but these factors will be significant only in the long run and cannot be confidently

predicted. What will be examined are the energy-related activities now in process in Alaska, and the directions in which they point.

2. Energy-related transportation. As previoulsy noted, the development of energy resources in arctic Alaska will undoubtedly entail substantial movement of materials by water. Marine activity may be principally a support function for exploration and construction operations, much as barge traffic to the North Slope has been utilized for Prudhoe Bay operations. Much more significantly for the Coast Guard the marine mode is a likely alternative for transporting oil and natural gas to collection points or to markets if production levels rise sufficiently.

3. Concerns for the natural and social environment. The concept of "progress" has recently undergone a significant redefinition in this country, where development of natural resources has always been considered desirable. The Trans-Alaska Pipeline was one of the first large-scale projects to be confronted by the new environmentalism; this was reflected not only as outright opposition but also resulted in construction of a greatly modified pipeline. The "TAPS precedent" will undoubtedly flavor any new plans for development in Alaska.

4. Canadian arctic developments. With a vast expanse of arctic frontage, Canada is much more oriented toward northern resources than is the United States. A number of Canadian

projects are underway in the high latitudes that are highly ambitious in scope and involve high technological sophistication. This type of arctic leadership may exert enough influence to pull arctic Alaskan development along the same lines. In addition, the very real possibility of Canadian energy exports to Japan through the Bering Straits presages a direct and significant impact on Coast Guard responsibilities.

5. The international perspective. A number of issues point to a growing international significance for the arctic. These include concerns such as protecting development efforts there, sovereignty issues related to transportation and resource exploitation, Soviet arctic efforts, and the potential for military and naval operations in the arctic. A federal interdepartmental policy group has been formed to study and discuss national policy for the area. A review of events in arctic Alaska and future icebreaker needs must also look beyond domestic commercial concerns to the exigencies of national security, and to the impact that present and prospective arctic developments will have on the world as a whole.

The foregoing issues form the framework of this study. While this overview and integrative approach in no way presumes to be comprehensive, it appears to offer the most clear-cut means of examining the complexities involved. The

framework fits well the most pertinent trends and influencing factors.

Chapters IV through VIII will examine each of the five issues in detail. Chapter IX will seek to combine and synthesize the results into useful conclusions about future icebreaking program requirements.

IV. ENERGY DEVELOPMENT

A. THE HYDROCARBON ENERGY PICTURE

In recent years world events have projected hydrocarbon energy, and particularly petroleum, into the international spotlight. The speed of this transition to prominence was remarkable not only for its convulsive abruptness but also for the incredible complexity of economic, political, religious and ethnic factors underlying the change. In one sense, the oil embargo of 1973 and the continuing price increases for this commodity have forced world awareness of the finiteness of petroleum and natural gas resources. The industrialized nations especially were relieved of their illusions that such cheap and convenient energy would last forever.

The "energy crisis" is perhaps more accurately labelled as a petroleum crisis (with its natural gas first cousin following closely in the same vein). In 1979, oil represented 46 per cent of primary U. S. energy consumption, and natural gas accounted for another 25 per cent [Ref. 47]. With the advantage of several years' hindsight, it can be seen how fortuitous the discovery of oil at Prudhoe Bay really was. Atlantic Richfield's 1968 announcement was made five years before the OPEC hammer fell, and added a significant flow of domestic oil to the American economy

relatively quickly. Although developments beyond the initial production area have proceeded slowly for a variety of reasons, the potential impact of arctic offshore and onshore resources is huge.

Estimation of hydrocarbon reserves is truly an art of augury. Figures are in abundance but, of course, come with no guarantees. In a global context, it is estimated that there are 648.5 billion barrels of proven oil reserves and 2,638 trillion cubic feet of natural gas worldwide [Ref. 138], of which some 10-12 billion are in Alaska. Estimates of undiscovered reserves are much less firm; U. S. Geological Survey figures, expressed in terms of probabilities, seem to be accepted as most authoritative. Table 4-1 contains USGS reserve estimates for Alaska and the continental U. S., and Figure 4-1 indicates the hierarchy of oil and gas categories.

The estimated Alaskan resources in Table 4-1 are significant, especially those for oil. It must also be considered that the continental United States has been much more thoroughly explored than has Alaska's northern areas, and figures for the latter may therefore be low. In the opposite vein, resources that are technologically recoverable may not be economically practical for production.

The supply-demand context is worth considering, although as indicated in the previous chapter, the complex realm of world events behind supply and demand is beyond the scope of this study. 1980 was the second consecutive year of

	95% Prob		Mean		5% Prob	
	Oil	Gas	Oil	Gas	Oil	Gas
Alaska:						
Arctic offshore	2 Bb	5 tcf	10 Bb	29 tcf	19 Bb	50 tcf
Arctic onshore	5 Bb	14 tcf	10 Bb	28 tcf	16 Bb	49 tcf
Bering Sea	0	0	--	--	8 Bb	18 tcf
Total Arctic Alaska	7 Bb	29 tcf	20 Bb	57 tcf	43 Bb	117 tcf
Total Continental U. S.	36 Bb	286 tcf	55 Bb	408 tcf	81 Bb	529 tcf

Notes: Bb = billion barrels of oil; tcf = trillion cubic feet of natural gas

Table 4-1: Estimated Undiscovered Recoverable Oil and Gas Resources
(U. S. Geological Survey figures, 1975)
[Reference 49]

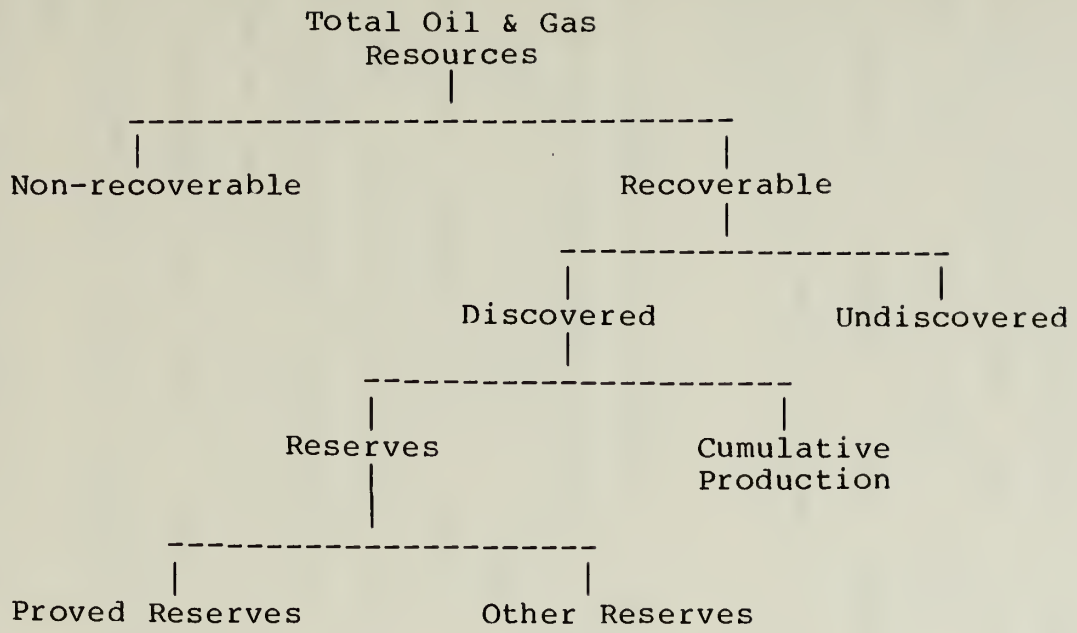


Figure 4-1: Categories of Oil and Gas Resources

declining U. S. consumption, matched with a 1.4 per cent increase in domestic production. The increase was due largely to stepped-up flow through the Trans-Alaska Pipeline (TAPS), but to some degree it also results from a slowing of the decline in "lower 48" production. World petroleum output simultaneously decreased 5 per cent, to its lowest level in three years [Ref. 138]. These trends seems likely to continue. Economic pressure for development of domestic sources will grow with each incremental rise in the price of imported oil.

Areas of present and potential hydrocarbon development fall into natural geographic divisions, illustrated by Figure 4-2. The Prudhoe Bay field, established by current production, lies between the immense National Petroleum Reserve-Alaska (formerly Naval Petroleum Reserve #4), and the William O. Douglas Arctic Wildlife Range extending eastward to the Canadian border. The Beaufort and Chukchi Seas are nearshore portions of the Arctic Ocean, with the Bering Sea encompassing Hope and Navarin Basins, Norton Sound and Bristol Bay.

The Department of the Interior's "Final 5-Year OCS Oil & Gas Leasing Schedule" of June 1980 utilizes these large geographic areas. Each lease area is broken down into small tracts averaging 6-8 square miles. Federal leasing of the outer continental shelf generally involves a two and one-half

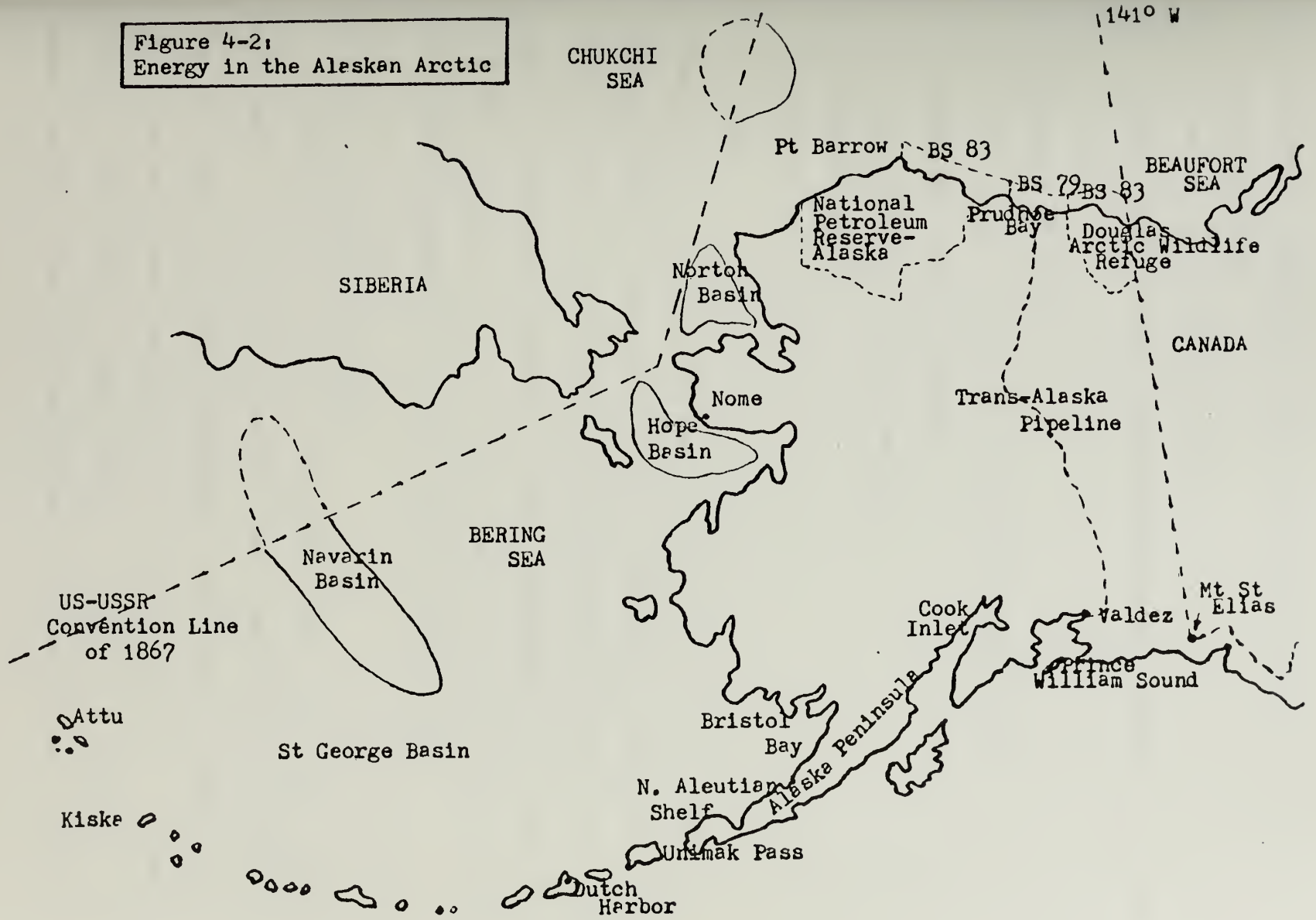


Figure 4-2:
Energy in the Aleskan Arctic
CHUKCHI SEA
141° W
Pt Barrow
BS 83
BS 79
BS 83
BEAUFORT SEA
National Petroleum Reserve-Alaska
Prudhoe Bay
Douglas Arctic Wildlife Refuge
SIBERIA
Norton Basin
CANADA
Nome
Hope Basin
Trans-Alaska Pipeline
BERING SEA
Navarin Basin
US-USSR Convention Line of 1867
Cook Inlet
Valdez
Mt St Elias
Prince William Sound
Attu
Bristol Bay
Alaska Peninsula
St George Basin
N. Aleutian Shelf
Kiska
Unimak Pass
Dutch Harbor

year process comprised of the following events:

--nominations

--tentative tract selection

--submission of draft environmental statements, for each tract

--public hearing

--submission of final environmental statements

--proposed notice of sale

--submission of state comments

--energy review

--notice of sale

--sale

Lease procedures are complicated by the fact that the state leases offshore areas inside of a three-mile boundary from any land area, with federal control outside this limit. The state of Alaska has disputed this arrangement by filing suit with the Supreme Court. It could be two to five years before the issue is presented to the justices [Ref. 126].

B. THE DEVELOPMENT PROCESS

Production of oil and natural gas in an arctic environment is a far more complex and expensive undertaking than has been the case elsewhere. Most large reservoirs of petroleum have been exploited in areas where it is easily produced and close to user markets. The oil crisis of the seventies has moved the development process to a new plane:

more expensive techniques such as deep-drilling and secondary recovery (injection of water or gas to maintain pressure) are now feasible, and adverse environments such as the North Sea and the arctic are increasingly attractive.

The difficulties facing arctic energy development stem from two physical features of the region: uneven annual distribution of daylight and low winter temperatures [Ref. 21]. These make most work highly seasonal, pose severe stresses on personnel and equipment, and inflict substantially higher costs. Construction of TAPS demonstrated how a month's slippage in a crucial step could mean a year's delay; and this seasonal inflexibility proved even more important in barging materials to the North Slope.

The process of oil and natural gas development can be subdivided into three phases. Exploration generally begins within a year after the lease sale and may continue up to four years. The purpose is to discover oil (or natural gas) and determine the economic feasibility for extracting it [Ref. 48]. Although analysis of surface geology and earth gravity surveys done with aircraft provide useful information, knowledge of the subsurface geology is necessary. This information has generally been gathered by seismic methods which more positively indicate structures favorable to the presence of oil [Ref. 8]. The existence of oil must then be proved by drilling. Seismic testing has been considered to pose little environmental risk, although

this assumption has been called into question for the effect that blasting and surface activity may have on certain wildlife species. Exploratory drilling is hazardous: the danger of blowouts and fire [Ref. 68] poses risk both to the environment and to personnel on the site. The Bureau of Land Management (Interior Department) must issue a permit prior to actual drilling.

Installation is the second phase of development, following successful exploration activities. In arctic environments, the duration could stretch from the fourth through eighth years after lease. A field plan must be approved by the Geological Survey. Platforms must be designed and constructed [Ref. 48]; this is difficult on tundra which turns to quagmire during summer, but especially so for arctic offshore work. Drilling from the low, flat Barrier Islands, or construction of artificial gravel islands seem to be preferred methods for exploratory work underway in nearshore Beaufort Sea areas. Man-made islands are notoriously expensive on the gravel-poor North Slope, and represent an extensive disruption of the natural setting. This solution is not at all viable for deeper water. In addition, 16 meters (52 feet) is considered the maximum for conventional jack-up rigs which are in any event a seasonal alternative [Ref. 165]. An ice island tested by Exxon in the Beaufort Sea was unsuccessful as a drilling platform due to undercutting by wave action [Ref. 126]. Deepwater rigs that

can withstand the forces of winter ice are still conceptual, although some interesting designs have emerged. Platforms with hollow, bell-shaped bottoms and sloped "icebreaking" sides have been proposed; they would be towed to the drilling site, filled with seawater and frozen [Ref. 74].

Beyond the problem of suitable platforms, production is generally less hazardous than putting in exploratory wells [Ref. 68]. This is due to the better understanding of geologic structure gained during exploration activities. The installation phase also requires development of support systems. Transportation for the increased number of personnel and large volumes of materials and equipment is needed, and if arctic efforts expand beyond the developed facilities at Prudhoe Bay, most transportation requirements will have to be met by shipping.

The final development phase is that of production. The arctic environment has stretched the time from drill permit to production from a normal five years to an estimated 8-10 years [Ref. 164]. It can only begin when the problems have been resolved and the stage set by successful installation. Production from the Prudhoe Bay field has been routine almost without exception when compared to the intense political battles and engineering obstacles of its installation. This stormy implementation was due in large part to transportation of the crude oil; movement of the petroleum to market was the focus of most, though not all, of the environmental

opposition. The same situation seems likely for further petroleum development in the Alaskan arctic.

A fourth, pre-exploration phase could be added to the foregoing description. Oil companies must decide, usually with very scanty and incomplete information, on lease areas to bid for. Acquiring leases represents a substantial outlay and typifies the gamble of petroleum and natural gas development. The level of risk reinforces a preoccupation with rapid payback for investments: the industry is reluctant to invest in projects which do not present a likely return within five years [Refs. 165, 168]. Throughout the development process, the risk of obtaining rights, discovering and exploiting commercially profitable quantities of resources is completely assumed by the companies. There are winners, like the Prudhoe Bay find, but there are also an ample number of expensive "dry holes." The unfavorable public image of the multinational companies largely obscures the degree of this development risk; and the escalating price of oil has probably increased the risk significantly. In dollar terms, a barrel of new oil is worth more and more. But oil must now be sought in unforgiving settings such as the arctic, where the total cost of development is so much greater.

C. AREAS OF DEVELOPMENT

With new events occurring almost on a daily basis, it is

difficult to present a "snapshot" view of the various areas of potential oil and gas development. However, the following paragraphs summarize the status of land and offshore regions in arctic Alaska, and descriptive information is presented in Table 4-2.

1. Prudhoe Bay

Alaska's first arctic oilfield has experienced three and one-half years of production, pumped over 1.5 billion barrels by the end of 1980 [Ref. 130], and reservoir pressures have decreased exactly as expected [Ref. 126]. At the current production rate of 1.5 million barrels per day, the field should last another 20 years, although a decline is expected around 1990 [Ref. 164]. Peripheral discoveries have been made in the area, and drilling to the west, northwest and northeast of the known reservoir gives indications of important new reserves [Ref. 99]. The producers plan to begin daily injection of 2.2 million barrels of seawater to maintain reservoir pressure, adding one billion barrels to reserves at a cost of $3 billion [Refs. 126,131]. Prudhoe Bay will, therefore, continue to be a significant production region until at least the end of the century.

2. Beaufort Sea

Currently scene of the most active exploration in Alaska, the shale formations under the Beaufort Sea are geologically the same as those containing Prudhoe Bay's oil. Moreover, economics has reduced the minimum field size from 1

Table 4-2: Reserves and Lease Scheduling for Arctic Alaska
[References 42, 48, 164]

Area Size/Water Depth	Estimated Recoverable Reserves: Pessimistic	Optimistic	Highly Optimistic	June 80 Lease Schedule	State Lease Schedule
Prudhoe Bay	10 Bb 26 tcf			(Producing)	(Uplands) Feb 82
Beaufort Sea Bids < 52′	1.5 Bb 3.5 tcf	3.0 Bb 7.0 tcf	6.0 Bb 14.0 tcf	Dec 79	Dec 79, Sep 80
Beaufort Sea	2.5 Bb 8.0 tcf	5.0 Bb 16.0 tcf	10.0 Bb 6.0 tcf	Feb 83	Feb 82, Feb 83, May 84
Hope Basin <60′	0.2 Bb 0.9 tcf	1.1 Bb 3.3 tcf	2.2 Bb 6.6 tcf	May 85	
Natl Pet Reserve	6.0 Bb (mean)				
WOD Wildlife Range 8.9 mm ac	4.74 Bb (50%) 8.41 tcf (50%)			(Not Scheduled)	
St George Basin 200-300′	0.5 Bb 3.3 tcf	5.0 Bb 13.0 tcf	9.5 Bb 26.0 tcf	Dec 82	
Navarin Basin 300-500′	0.3 Bb 1.0 tcf	2.0 Bb 5.4 tcf	4.0 Bb 10.8 tcf	Dec 84	

Table 4-2: Reserves and Lease Scheduling for Arctic Alaska
(Continued)

Bristol Bay	0.5 Bb	2.5 Bb	5.0 Bb		
200-300′	1.6 tcf	5.0 tcf	10.0 tcf	(Not on	
Norton Sound	0.5 Bb	2.2 Bb	4.4 Bb	Schedule)	
50-100′	1.0 tcf	3.0 tcf	6.0 tcf	Sep 82	Nov 82
Chukchi Sea	3.0 Bb	10.0 Bb	20.0 Bb		
<60′	8.5 tcf	49.5 tcf	99.0 tcf	Feb 85	

Notes: Bb = billion barrels of oil; tcf = trillion cubic feet of natural gas

The state controls leases inside a 3-mile offshore boundary; areas outside are federally controlled

The Chukchi Sea lease is contingent on a reasonable assumption that technology will be available for exploration and development of the tracts

areas close to Prudhoe [Ref. 126]. In December 1979, 20 major oil companies paid $491.7 million for 25 federal tracts [Ref. 151], and $567.4 million for 53 state-managed tracts [Ref. 126]. Only the shallow protected waters inshore of the Barrier Islands are now attractive from a technological standpoint, and the 1979 sale brought no bids beyond a depth of 16 meters (52 feet).

Beaufort Sea development, for all of its attractiveness, is fraught with complications. Separation of federal and state lease control has resulted in the frequent inability of companies to do joint drilling, with subsequent higher costs [Ref. 165]. A map of offshore lease areas is convoluted by the location of the Barrier Islands and the three-mile demarcation lines; consequently some of the lease areas are, as previously mentioned, in dispute. For various political and legislative reasons, no efforts to settle the federal-state disputes were made before the lease sale [Ref. 126]. Future court action may change tract management in some areas.

An additional obstruction to Beaufort Sea exploration is a lawsuit brought in federal district court by environmental groups and Alaska natives, claiming the Interior Department failed to comply with environmental regulations prior to conducting the 1979 sale. However, the court has cleared the way for exploratory drilling during winter 1980-81, allowing the Interior Department to appeal.

A similar lawsuit has been brought in Alaska state courts. The issue has been further complicated as the North Slope borough has indicated a desire to exert local control by restricting some tracts for subsistence use only. If successful, such a move would render them worthless as oil properties [Ref. 126].

A more significant boundary dispute could emerge when the February 1983 lease sale opens Beaufort Sea tracts further to the east and west. The offshore U. S.-Canadian border is the subject of disagreement, and with extensive development activity already well underway in the Canadian Beaufort (see Chapter VII), the disputed boundary adds another factor of uncertainty [Ref. 126]. The actual value of the 1983 tracts will depend, however, on results of current offshore work in the Beaufort Sea [Ref. 99].

Work planned or now in progress involves drilling from the Barrier Islands, from shore or from gravel islands; it is possible to reach up to 7000 feet laterally from a drill site [Ref. 126]. SOHIO, Exxon, Conoco, Shell, Mobil, Phillips, BP Alaska and Chevron have all begun exploratory drilling [Ref. 99]. Exxon reportedly scored two promising discoveries a half-mile offshore and beyond the known limits of the Prudhoe field, although little information was released by the company [Ref. 109]. Even though construction of gravel islands costs $1 million per foot of water depth and requires permits from the Army Corps of Engineers and

Alaska Department of Natural Resources, Exxon, Amoco, Union of California and ARCO have applied to build four of the islands [Ref. 119].

The Beaufort Sea is now in the limelight for new oil discoveries. The activity has not yet, however, revealed any major new finds. The answers should be quickly forthcoming.

3. National Petroleum Reserve-Alaska

This huge area, covering over six per cent of Alaska's land area, has been long associated with oil potential. Early attempts at exploration were disappointing. Since its renaming and administrative transfer to Interior Department control in 1977, Husky Oil has conducted exploratory work under government contract. The results have also been discouraging: 22 exploratory wells have yielded 22 dry holes [Ref. 99] and seismic work has been equally fruitless [Ref. 52]. Some exploration is still in progress, and Congress has authorized $117 million for more drilling prior to offering the area for lease in August 1982, as President Carter recommended [Ref. 99]. The Department of the Interior isssued a call for NPR-A nominations in late 1980 [Ref. 124].

For all of its disappointments thus far, the oil and gas future of NPR-A is not completely bleak. Small wells have produced gas for the community of Barrow for a number of years. Additionally, the undeveloped Umiat field is known to contain 70 million barrels of oil [Ref. 126]. The sheer vastness of the area tends to mitigate the negative results

of exploration to date; and the oil companies are eager to have their "own look" [Ref. 99]. The reserve's proximity and geologic similarity to the Prudhoe field makes further exploration reasonable.

4. William O. Douglas Arctic Wildlife Refuge

Recognized for its abundance of wildlife and set aside as a preserve for that reason, this 8.9 million acre range also has the perhaps unfortunate distinction of being prime oil and gas territory. The area is considered to be far more promising than NPR-A. The Geological Survey's 50 per cent resource probabilities listed in Table 4-2 are hardly certain; they were made without subsurface seismic data and depend heavily on extrapolation of figures from nearby areas. Although aeromagnetic, gravity and surface geology surveys have been made, seismic data is needed for confirmation of resource presence [Ref. 99].

The subsurface rock structures of the range, while younger than those at Prudhoe Bay, are similar to oil-bearing structures in the Canadian Beaufort Sea [Ref. 126]. Alaska senator Ted Stevens, echoing an ARCO statement, labelled the wildlife range as the most promising oil and gas area in the country [Ref. 111]. This opinion has been reiterated by the Alaska Division of Geological and Geophysical Surveys [Ref. 123].

The range is home to polar bears, wolves, musk oxen and migrating birds, as well as the summer calving grounds

for an estimated 130,000 caribou [Ref. 102]. As such, it became a bitter issue in the Alaska lands turmoil that was decided by Congressional action in November 1980 (see Chapter VI). Senator Stevens has gone on record stating that the industry has proved drilling not to be harmful to visiting caribou herds [Ref. 111]. The Alaska lands bill has provided for some seismic exploration in the range two years after enactment (i. e., in late 1982), with a Congressional decision on leasing after five years [Ref. 111]. In any event, seismic testing should provide a more complete understanding of oil and gas potential.

5. Bristol Bay

Geologists theorize that these shallow waters may be extremely promising, and they are considered the industry's first choice outside of the North Slope and Beaufort Sea. However, little firm data exists. A good deal of the bay was excluded from the Interior Department's lease schedule in deference to state requests made on behalf of fishing interests [Ref. 99], but a sale labelled "Northern Aleutian Shelf" is scheduled for October 1983. This lease area covers the coastal waters of the Alaska Peninsula forming the southern portion of Bristol Bay. The exclusion of Bristol Bay leasing is therefore partially a matter of semantics [Ref. 174]. The bay is an abundant fishing area, with 1-3 feet of ice cover for 7-8 months each year [Ref. 48].

6. St. George Basin

This Bering Sea region is marked by less extensive and severe ice conditions than Bristol Bay [Ref. 48] and was once considered most promising. It has, however, been downgraded because of disappointing stratigraphic testing [Ref. 99].

7. Navarin Basin

The area is considered to have good potential. Based on some seismic work, it could rival Bristol Bay in promise [Ref. 99]. Oil discoveries on the Russian mainland tend to support the geologic prospects of the area [Ref. 126]. Year-round exploratory drilling would be feasible since the waters are mostly beyond the ice edge in all but the most severe winters [Ref. 48].

8. Hope Basin

Ice cover generally ranges from 4-6 feet for up to six months [Ref. 48]. The area's potential has been downgraded somewhat because of dry holes drilled on the adjacent shoreline [Ref. 99].

9. Norton Sound

A 16-company stratigraphic test was conducted 45 miles south of Nome in the summer of 1980 [Ref. 126], and ARCO plans additional testing in 1981 [Ref. 164]. Little firm evaluative information is currently available. Ice cover is normally three feet, and up to six feet thick in severe winters, for 6-7 months [Ref. 48].

10. Chukchi Sea

Little is known of potentials for the most remote of the prospective development areas. Monumental drilling and transportation problems exist [Ref. 99], and the federal schedule included the provison that leases will be made only if it can be reasonably assumed that adequate technology is in existence. Like the Navarin and Hope Basins, the Chukchi Sea borders the US-USSR Convention Line of 1867; if extraction from these fields occurs, it will raise the questions of drainage from reservoirs on the Soviet side and the possibility of Soviet response to activity in the area [Ref. 99].

D. FUTURE DEVELOPMENT

A huge rush of optimism about Alaska's oil and gas potential followed the Prudhoe Bay discoveries. While there are promising prospects and some peripheral discoveries have been made, there have been no subsequent finds on the same level as Prudhoe Bay. A recent article in an industry periodical asked, "Alaska: will it ever live up to its potential?" [Ref. 99]. It may be that Prudhoe will prove to be the only major oil and gas field in arctic Alaska; but it is also possible that twelve years have not provided sufficient time to adequately explore such vast areas, especially given the technological, political and economic barriers confronting arctic development. The future course of development, however, is most relevant.

Table 4-3: Estimated Lease Sales and Production Dates for Arctic Alaska
[Reference 48]

	Projected Lease Sale	Production: Pessi-mistic	Production: Opti-mistic	Production: Highly Optimistic
Beaufort Sea	1979	1986	1986	1986
Beaufort Sea	1986	1998	1998	1998
St George Basin	1984	No Sale	1996	1996
Navarin Basin	1990	No Sale	No Sale	2000+
Bristol Bay	1987	No Sale	No Sale	1996
Norton Sound	1981	1995	1991	1991
Hope Basin	1986	No Find	1997	1997
Chukchi Sea	1988-89	No Sale	2000+	2000+
Daily Peak Production (bbl)		1986: 1.67 mm	1990: 2.38 mm	2000: 3.57 mm
Maximum Production & Exploration Rigs, Outer Continental Shelf		15	35	71

Studies undertaken in recent years have estimated recoverable reserves and development dates. One of the most comprehensive was done by Energy Resources Company and E. G. Frankel (ERCO/EGF) for the Coast Guard [Ref. 48]. Some of the quantitative results of this study, submitted in January 1980, are summarized in Tables 4-2 and 4-3. The study projected three possible scenarios: pessimistic, optimistic and highly optimistic development. The resulting numbers, although representing educated guesses based on the best information available, are unconvincing even a year after the study's completion. As can be seen in Table 4-3, the projected lease sale dates are mostly longer term than those on the June 1980 lease schedule. The future of arctic energy development is far too fuzzy for such precision in projecting.

The national political setting in particular is in a state of flux with the election of Ronald Reagan in November 1980. His advisers and Secretary of the Interior have generally taken a pro-growth, pro-production stance; and oil industry perceptions of the new administration's direction include:

--an emphasis on increased production, rather than conservation, in response to the "energy problem" [Ref. 120].

--easement of environmental rules, leading to faster development [Ref. 120]. Consolidating the environmental statements requirements required for each tract into a single document covering the entire lease area is one possibility [Ref. 164].

--accelerated leasing of federal lands, including those in Alaska [Refs. 120, 129]. Telescoping the leasing process down to 24 months is a real possibility [Ref. 174].

The announcement of immediate decontrol of oil prices within days of Reagan's inauguration is further evidence of his administration's policy direction, as is Energy Secretary Watts' restoration of offshore California areas to the lease schedule. National policy is likely, therefore, to change in favor of more immediate availability of federal land for exploration. As the ERCO/EGF study noted, expert opinion seems in agreement that Alaska contains some of the nation's most promising oil and gas areas; but there is not agreement on the extent of the resource or on a timetable for development [Ref. 48]. Stepped up exploration does not ensure that commercial quantities of the resources will be found, nor that exploiting arctic areas will be preferable to opportunities elsewhere.

From deduction and a combination of the information currently available, the following flow of events seems most likely:

--any significant new production will come first from the nearshore Beaufort Sea. Even if only minor finds are made, the proximity to TAPS will make their exploitation attractive. Oil should begin flowing by 1988, but as a General Accounting Office report noted, it will primarily offset declining Prudhoe production [Ref. 110].

--accelerated seismic exploration in the Douglas Wildlife Range seems likely. The area could well symbolize a change in national policy to favor resource production over somewhat esoteric and disputed environmental/biological arguments. If significant resources are found, the pressure to develop them

will be intense since the area will be easier to exploit than either the deeper Beaufort Sea waters or the Bering Sea areas. Production, though with careful controls, will probably result early in the next decade.

--the National Petroleum Reserve is more speculative. Exploration leasing could well be expedited, and any commercially sized finds will be rapidly exploited since the area does not have the wildlife constraints of the Douglas Range. It would likewise be preferred over the offshore areas. Production could begin by the end of the decade.

--successful nearshore Beaufort exploration will enhance the attractiveness of the deeper waters, but movement of production into deep water will be delayed by onshore drilling, if it unfolds. The heavy pack ice and depth of water problems will keep production from occurring until near the end of the century.

--production from all areas of the North Slope will not exceed the two million barrels per day capacity of TAPS before 2000.

--pressure for a step up of the scheduled lease of Bering Sea areas will emerge only if offshore and onshore North Slope results are disappointing. This assumption tends to push Bering Sea production almost to the end of the century. It seems unlikely that the industry will scatter its efforts widely; reinforcing this tendency is the problem of logistics, advanced technology requirements and lack of data on Bering Sea reserves.

--Bristol Bay may be an exception of the item above. Current favorable prospects make it a prime candidate for inclusion on a revised lease schedule. If less-restricted exploration is allowed and produces significant reserves, development could proceed closely on the heels of North Slope production and in advance of other Bering Sea areas.

--the Chukchi Sea will be the last area to experience exploratory drilling and production. Logistic remoteness and weather/ice problems make it unattractive as long as other areas offer reasonable possibilities. Production will not occur until after 2000.

The foregoing outlook is primarily a set of reasoned guesses; Figure 4-3 organizes them on a time scale for comparison. A key element of the reasoning bears further

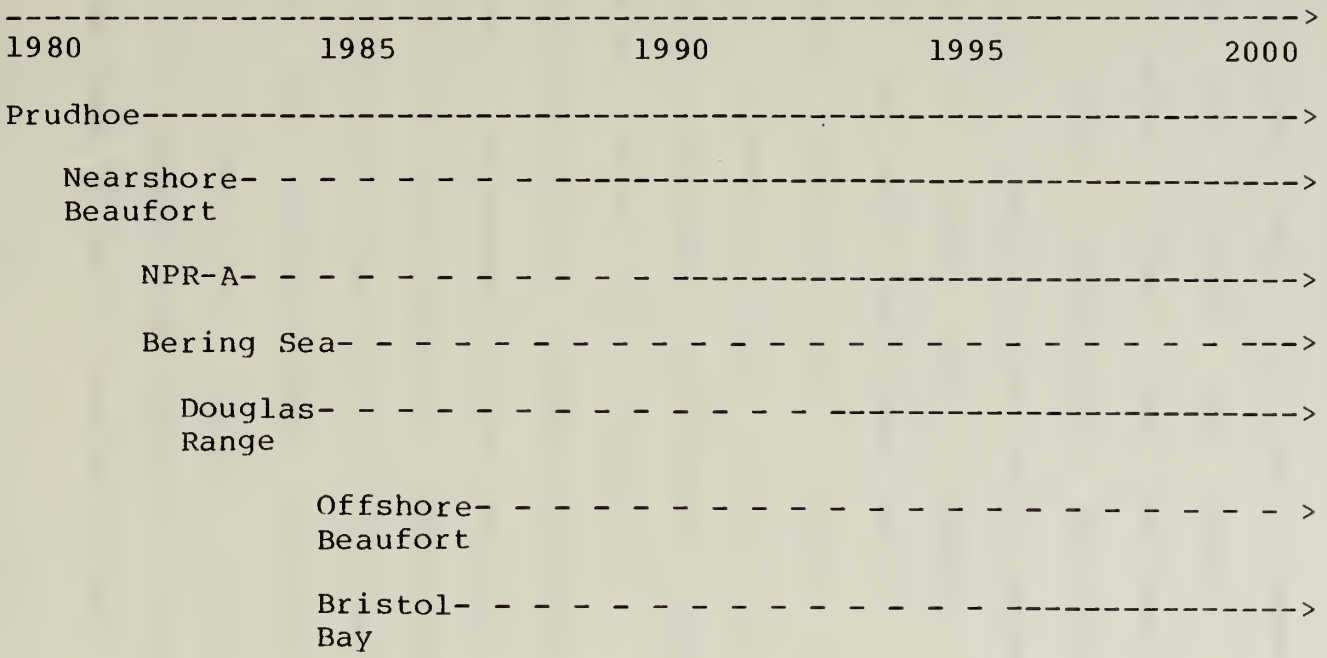


Figure 4-3: Predicted Exploration and Production Timetables

Exploration - - -> Production------>

mention. The possible development areas represent many differences in terrain, weather and ice conditions, legal status, proximity to logistic bases, proximity to established production centers, etc. The view is taken that the industry as a whole will develop new areas in an essentially sequential manner, rather than simultaneously. This process is now in effect. Prudhoe Bay was the first step and is being followed by Beaufort Sea exploration. Industry will "feel" for the next best prospect by simultaneous exploration, but major development effort will be focused on one geographic province at a time. The size of the investment, the technological difficulties, the lack of good information on resources, regulatory procedures and legal challenges all make this reasonable. Development will proceed from the easiest to most difficult environments.

A primary contingency is also involved. The degree of success of North Slope areas, as represented by producible resources, will determine the rate of development of Bering Sea fields. The Beaufort, NPR-A, and Douglas Range are much more attractive and have a higher probability of resource presence; but disappointing results on the North Slope should increase the pace of Bering Sea development.

General as it is, the outlook presented forms a primary part of understanding Alaska's more comprehensive future. Energy development is in many respects the pacesetter of

events in the region. Transportation, the subject of the next chapter, is closely associated. Though greatly dependent on the energy picture, transportation also serves as an input to the production decision process.

V. ENERGY-RELATED TRANSPORTATION

It is tempting and less complicated to examine arctic Alaska's potential energy resources without considering transportation. Although the previous chapter discussed development as if it were a problem separate from transportation needs, this division is largely artificial. Transportation must be available to support the exploration and installation phases, and a production decision is dependent on a transportation system to move the product. Yet transportation is not merely one of several logistic elements. The applicability of various transportation modes affects the attractiveness of developing a prospective area almost as much as the presence of hydrocarbons. The previous chapter alluded to logistic convenience, and the full impact of transportation will be pursued here.

Energy-related transportation can be viewed as having two components: transportation supporting the development process, and transportation of the product. Both were significant in the development of Prudhoe Bay, and both will figure prominently in future energy activities.

A. TRANSPORTATION FOR ENERGY DEVELOPMENT

Development activity in the Alaskan arctic is, and will be, strongly influenced by remoteness from commercial and

industrial centers and by large material requirements. The latter encompass everything from drilling equipment to the awesome amount of support facilities that accompany the preparatory phases as well as actual production. The TAPS experience is instructive. The pipeline and terminal complex in Valdez often attract the bulk of attention, but to produce oil at Prudhoe Bay it was necessary to build a small city. Most of the cargo tonnage for Prudhoe development was transported by water.

The gently sloping continental shelf of Alaska's arctic coast precludes the use of deep draft freighters. Prudhoe Bay construction relied on a proven standby, the tug and barge combination, which has served the region since the mid 1950s [Ref. 40]. In 1969, 100,000 tons went to Prudhoe Bay by this mode [Ref. 71]; 1970 was the peak year with 180,000 tons, and volumes declined after a 70,000 ton lift in 1974 [Ref. 91]. Annual resupply continues, with Crowley Maritime as the principal carrier to Prudhoe Bay [Ref. 48].

Major tug-barge efforts have generally operated in flotilla form. The transit is generally made past Point Barrow, to offload in Prudhoe Bay and return within a six to eight week "window" allowed by ice conditions in August and September. North Slope tugs have propulsion systems ranging from 2000 up to 9000 horsepower. The largest barges are 400 by 100 feet wide, with loaded drafts to 20 feet; the lightering barges can operate in depths over seven feet [Ref. 164].

Material movements by tug and barge appear to be an assured part of future development activity. Even though ground transportation to Prudhoe Bay is now possible over the pipeline haul road, and certain cargoes can be lifted by air, the economics of the situation indusputably favors water transport. The tug-barge combination will remain as the primary mode for movement of bulk cargo in support of arctic resource development [Refs. 40, 164].

Barge sealifts will again reach high tonnage levels as nearshore Beaufort Sea exploration continues. Industry planning envisions a lift of 170,000 tons during the summer of 1983 or 1984, or possibly in both years [Ref. 172]; the capital investment of such an operation has been estimated as follows [Ref. 164]:

170,000 tons at $1.5 million per 1000 tons	$255 million
25 barges at $4.0 million each	100 million
25 barges at $4.0 million each	100 million
TOTAL	$455 million

The size of such an investment is considerable, especially when pitted against uncertain seasonal conditions and such a tight time frame. This is perhaps the major drawback of tug and barge transportation: it is very much a matter of having all the eggs in one basket. The opportunity cost of a barge convoy includes not only the risk of lost or damaged vessels and cargo and the time value of the investment, but also the possible loss of an entire working season [Ref. 164].

Tug-barge transportation will also be called upon for for support as development activities expand into the Douglas Range, the National Petroleum Reserve, and the Bering Sea. The latter area will afford easier and lengthier access to marine transportation due to less strenuous ice conditions.

A second category of marine traffic will also support the development effort in offshore areas. Workboats will service drilling rigs during the ice free season, although helicopters will undoubtedly be widely employed for this purpose as well. The Energy Resources-E. G. Frankel (ERCO/EGF) study of petroleum development impact estimated workboat totals for continental shelf areas at 25, 70 and 120 for its pessimistic, optimistic and highly optimistic scenarios, respectively [Ref. 48]. The volume of such boating traffic depends directly on the level and timing of offshore drilling.

B. TRANSPORTATION OF ENERGY PRODUCTS

Long distance, high volume transportation of oil and natural gas has traditionally involved either the tank ship or the pipeline. Selection between these two modes is usually clear cut, since the latter is principally for overland use and the other an overwater method. The transportation decision for Prudhoe Bay was unusual in that both modes, in specialized forms, were active possibilities. It is noteworthy that the transportation system ultimately

implemented involves both tankers and a pipeline.

The TAPS debate brought forth a lively discussion of alternatives, including some outside the tanker-pipeline tradition. Future arctic development will have a variety of choices, as outlined below.

1. Land-Based Modes

Potential arctic pipelines have at least one factor in their favor: a functioning 800-mile prototype, winding over a variety of arctic and sub-arctic terrain. Whatever criticisms may have been levelled by opponents, whether economic, aesthetic or environmental, it cannot be argued that TAPS fails to move oil effectively. Whether another pipeline could be built is open to question. The stormy birth of TAPS also provides ample arguments against it. Although it seems likely to be completed, at a cost of $40 billion, the natural gas pipeline also faces serious obstacles [Ref. 169].

With TAPS operating at three-quarters of its designed capacity, an additional pipeline or pipelines from the North Slope would result only if production significantly passes two million barrels per day. This economic sense is reinforced by federal lease requirements mandating the use of existing pipelines if they are available [Ref. 165]. Pipeline delivery of Bering Sea resources is an alternative, though a far-fetched one. The brightest prospect for additional pipelining in arctic Alaska is for feeder lines connecting producing North Slope wells with TAPS.

Transportation of crude oil by railroad is also a possibility, but not a leading contender in the current discourse. Extension of the Alaska Railroad to deliver oil was studied and recommended by an independent consultant during the TAPS decision process. A Canadian Transport ministry report estimated that 360 locomotives and 11,000 tank cars would be needed to move two million barrels per day through Canada to the continental United States [Ref. 3]. Building a railroad to the remote areas of development is hardly less of an engineering feat that is pipeline construction.

2. Icebreaking Tankers

The most glamorous of the marine transportation systems, a fleet of strengthened high-powered tankers, again arises as an alternative for moving arctic oil and gas. The technology, though not yet in routine application, has been tested and it is being actively developed for use in arctic Canada (see Chapter VII). Long, parallel-sided vessels with properly designed bows have proven much more effective than icebreakers so far built. The MANHATTAN proved the economic and technological feasibility of arctic navigation by tankers; however, as one study cautions, similar feasibility of an arctic oil transportation system cannot be inferred from this [Ref. 63].

The MANHATTAN voyages did gather valuable data, and the study continues. The U. S. Maritime Commmission (MARAD)

not unsurprisingly supports the concept, and is involved in a number of projects related to the marine mode:

--a joint industry-government pilot project has been proposed for building one or two icebreaking tankers or liquified natural gas (LNG) carriers and an arctic terminal [Ref. 57]

--a Memorandum of Agreement with the Canadian Marine Transportation Administration was executed in 1980, providing for data-sharing on arctic marine transportation systems [Ref. 57].

--in conjunction with the Coast Guard, the state of Alaska, and the Alaska Oil and Gas Association, MARAD has conducted "trafficability" studies using the POLAR-class icebreakers to assess the feasibility of a "polar tanker" design [Ref. 30, 31]; and in February 1981 POLAR SEA was underway with the goal of a winter transit to Prudhoe Bay [Ref. 167]. Phase IV of the program is a possible 1982 traverse of the Northwest Passage [Ref. 57].

--a study of various vessel systems to move crude oil, LNG and methanol from NPR-A to the U. S. east and Gulf coasts was conducted, using computer simulation of vessel performances. The conclusions support the feasibility of marine systems [Ref. 57].

--a 1979 MARAD report concluded that it would be technically feasible and economically attractive, in comparison with intercontinental pipelines, to transport petroleum products from the North Slope to the U. S. east coast by icebreaking tanker [Ref. 56].

The dimensions of the proposed vessels border on the incredible. Demands of the operating environment require great structural strength, 100,000 to 200,000 shaft horsepower (SHP) for maneuverability and icebreaking ability, and enormous size in the 150,000 to 300,000 deadweight ton (dwt) range [Ref. 40]. The trafficability studies postulate an even larger tanker: 1200 feet in length, 371,000 dwt, 210,000 SHP and an 80-foot draft. Such a ship would be

capable of year-round operation from Unimak Pass to the Arctic Circle. Bering Sea operations would be possible with even less power [Ref. 30, 31].

As the concept is applied to arctic Alaska, two routes are possible. The Bering Strait-Unimak Pass corridor appears to offer less resistance, and obviously so for production from the Bering Sea; the Northwest Passage is much longer and more demanding [Ref. 29]. A Canadian analysis of ice data found the "western" route to be more unpredictable due to dynamics of the ice pack, but even so projected that no significant hindrance would result in nine years out of ten. Extreme conditions would involve only two to five days' delay [Ref. 78]. This analysis, however, assumes that vessels would have to round Point Barrow in deep water well to the north and fight the arctic ice pack. Arctic Ocean conditions feature hard multiyear ice and pressure ridging from the moving pack. Bering Sea conditions are far less demanding.

The Northwest Passage's most attractive feature, however, involves the distribution of demand. The eastern seaboard faces the greatest shortfall in oil. The length and rigors of the Northwest Passage thus become less preclusive if the route allows a stable flow of oil to the Atlantic states.

3. Icebreaking Tug and Barge Combinations

This alternative exists as an extension of the North Slope's current "workhorse" of marine transportation. Crowley Maritime has 30 9000 horsepower tugs and three icebreaking barges employed in Alaska operations. The barges are pushed by one or two tugs in stern notches, and have navigated in ice up to six feet thick [Ref. 172]. The concept is readily applicable to crude oil transport, where suitable tug horsepower and the weight of an oil-laden barge would provide reasonable icebreaking capability. Such a system would be cheaper and more flexible that a fleet of icebreaking tankers by separating the propulsion from the cargo tanks: barges, for example, could be filled at production areas and retrieved as necessary by tugs. The major drawback is that lacking the rigid construction of a single ship, a tug-barge combination could not operate in ice conditions as demanding.

4. Submarines

One of the more exotic alternatives, yet intriguingly close to technological feasibility, the use of tanker submarines was proposed during the Prudhoe Bay development. The Electric Boat Division of General Dynamics proposed a fleet of 300,000 dwt nuclear submarines, each carrying 1.2 million barrels of crude oil. They would transit beneath the arctic ice pack from Prudhoe Bay to the Atlantic coast [Ref. 83]. A MARAD study found 400,000 ton submarines, each 15-20

times the size of the Navy's Trident, to be highly competitive with pipelines or icebreaking tankers [Ref. 83]. Another study found a 170,000 to 250,000 dwt submarine "practical and reliable" for delivery to east coast ports, with lower transportation costs [Ref. 63].

Attractive as this may sound, submarine oil transport would entail even greater degrees of technological risk than icebreaking tanker development. Though virtually negating the problem of ice navigation, such a project must face the nuclear energy controversy. Submarines of the size proposed have never been built and would certainly be more expensive than surface shipping.

5. Surface Effect Vehicles

Surface effect, or air cushion, vehicles (SEV) offer another non-traditional approach to the transportation problem. Feasibility studies extrapolated a 10,000 ton tanker vehicle design from operational models under 300 tons, and evaluated it as a solution for Prudhoe petroleum transport [Refs. 54, 55]. The system envisioned would entail a number of SEV tankers ferrying oil to a specially outfitted tanker, a floating port that would move with the seasonal advance and retreat of ice; the cargo would then be transferred into conventional tank vessels for the open water journey. The advantages unique to such an arrangement would be a 60 knot speed and the ability to easily traverse water, ice or land without hindrance. With each SEV seasonally

averaging 0.7 to 5.6 round trips per day, it was estimated that Prudhoe output could be handled by 28 vehicles. This would result in the same transportation cost per barrel as TAPS, but with one-third the capital investment [Ref. 54]. The feasibility of a surface effect route through the Northwest Passage was also evaluated [Ref. 55].

SEV transport of oil is limited by the high fuel consumption and the operational difficulty of traversing pressure ridges in the ice. It has been estimated that to avoid impassable ridging would require "meandering" up to four times the straight line distance to be travelled [Ref. 53]. This renders the SEV alternative seriously deficient.

6. Marine Transportation Support

It is tempting to see marine transportation systems as a collection of more or less exotic vessels or vehicles. The less glamorous side, however, involves an extensive set of support sub-systems that will enable a marine transportation system to function in an arctic environment.

A crude oil loading terminal, for example, would involve heavy capital expenditures and would be a particular problem in the shallow water of the North Slope. A marine terminal would need mooring facilities, storage capacity, provisions for ballast treatment, fueling arangements, safety equipment and personnel facilities as a minimum. A conceptual design has been done for a bottom-founded Beaufort Sea terminal, 4.9 miles offshore in 120 feet of water, with a

5.2 million barrel storage capacity. It would be operational 10-11 months of the year, being shut down when ice prevents tanker mooring [Refs. 36, 57]. A terminal for submarines would involve even greater complexities, especially if underwater loading were to be a feature.

A project more suited to near term use involves development of Nome as a deepwater port. In November 1980 the city passed a bond issue supporting a state-financed $70.4 million facility; it would consist of a 3600 foot causeway to provide 22 feet of water at the dock. With a 1983-84 completion target, the port would support land based mineral extraction, offshore drilling activity and general cargo handling. It is an example of how Alaska's oil revenue may be used, since income generated by the facility will cover only operation and maintenance costs with no capital recovery [Ref. 73].

Other necessary support functions, many of which involve government agencies, include:

--bathymetry work, since bottom depth information is inadequate in the Bering Sea and arctic coastal areas [Ref. 41]. For example, a number of pinnacles have been discovered in recent years in Viscount Melville Sound which would be major hazards to marine transportation. This bathymetry problem is especially important for large draft-constrained vessels that must navigate close inshore to avoid ice.

--navigation systems. Satellite navigation is available and the Bering Sea has Loran-C coverage, but local shore-based aids will be needed.

--communication systems, which will require upgrading. Long range frequencies are often unreliable due to atmospheric conditions where short range VHF-FM

communications are not impaired [Ref. 40]. A VHF-FM net would require an extensive new system of transmitting stations or remote transmitters.

--pollution response capability. This would be a certain requirement since the potential damage of spilled oil is very high. Again, the TAPS experience sets a precedent in requiring the industry to maintain extensive prevention, containment and cleanup capabilities.

--search and rescue forces, filling a definite need in the adverse arctic marine environment.

--a weather and ice information system, which would be one of the most important elements. Arctic vessels need both long range and localized ice information, and timely promulgation can greatly enhance vessel movement. The Naval Fleet Weather Facility now handles ice prognostication. By the end of 1981 a much-improved ice dynamics model [Ref. 89] will be used in ice forecasting, greatly improving the semi-empirical model employed since 1968 [Ref. 175]. The National Weather Service would undoubtedly assume the ice forecasting function as a statutory responsibility when extensive commercial need arises [Ref. 41]. Ice forecasting projects such as the 1975-76 Arctic Ice Dynamics Joint Experiment (AIDJEX) have been performed. But improved data collection and forecasting, perhaps utilizing impulse radar, satellite sensors and side-looking airborne radar would also be needed [Ref. 40]. A requirement for more weather data could also be expected.

--traffic control and monitoring. The environmental sensitivity of petroleum transportation could be reflected in a requirement for a traffic system, much as one was required for TAPS tankers in Prince William Sound. Loran-C retransmission (where an electronic positioning signal is received by a vessel and retransmitted to a control center) offers a cost effective means of monitoring vessel positions. Navigation, communications, search and rescue, and weather and ice information could all be combined, with the control function, in a single system.

C. BY LAND OR BY SEA: THE TRANSPORTATION DECISION

In the most general sense, the transportation decision for future Alaskan energy resources will involve a choice between land-based and marine transportation systems. From the standpoint of technology and risk involved in applying

it, the issue can be further refined into a choice between new pipelines, and the introduction of a marine system (or systems).

Pipeline transportation has the following characterictics [Ref. 165]:

--high cost of construction in extreme conditions.

--great environmental impact, but little risk of further degradation once constructed.

--geographic inflexibility for input and output, and a limited economic range of volume.

--utilization of proven technology.

--high likelihood and ample precedent for opposition from a number of quarters.

In contrast, a marine transportation system can be described as follows [Ref. 40]:

--a lower economic threshold needed for production.

--great flexibility in departure and arrival points, and the ability to transship (e. g., transfer of cargo from specialized ice capable vessels to less expensive tankers).

--unlimited incremental expansion of volume.

--vessel construction in temperate climates, though with legal constraints requiring that cargo between U. S. ports be carried in U. S. built, U. S. flag vessels.

--a requirement for expensive and technologically unproven North Slope terminal facilities.

--sovereignty problems, for delivery to the Atlantic coast.

--substantial environmental risk during operation.

--problems with maintaining uniform flow, subject to the vagaries of weather, ice and seasonal conditions.

In addition to these factors, utilization of pipelines or marine systems is dependent on the geography of development. The Bering Sea areas seem ill-suited for pipeline transport and are attractive prospects for a marine system. New capacity will become necessary for North Slope production only if a surge of new oil materializes; TAPS can carry 500,000 additional barrels a day. As previously mentioned, feeder pipelines may be employed as production expands outward from the existing field. The Chukchi Sea will require marine transport, either for the entire journey or to feed it into TAPS.

The future of marine transportation is a bright one. It is supported by the Department of Energy and MARAD [Ref. 165], and much of the front-end risk of developing new arctic marine systems is being borne by Canadian firms. As petroleum development activities expand outward from their "cradle" at Prudhoe Bay, the marine mode will be examined more closely. The relationship between transportation and development also functions in the opposite direction: the availability of feasible marine alternatives will make some lease areas more attractive for production.

Building on the development forecast sketched at the end of Chapter IV, the following events seem probable:

--production from the North Slope will not exceed two million barrels per day before 2000. New production from the National Petroleum Reserve, Douglas Wildlife Range or the Beaufort Sea will come on stream as Prudhoe production declines, and additional oil will bring TAPS up to full

capacity. While producible reserves may be be available by the early 1990s to surpass TAPS' capacity, the increment will not justify an additional transportation system.

--The Alaska Natural Gas Transportation System will be completed by the late 1980s. It will carry all natural gas from the North Slope.

--there will be no other major pipelines built for primary transportation of petroleum [Ref. 161]. New development of North Slope reserves may necessitate feeder lines to TAPS. The gas line now under construction and TAPS perhaps represent the zenith of large scale overland pipelines in this country.

--the Bering Sea areas and the Chukchi Sea will utilize marine systems, if and when they are developed. The success of Canadian arctic transportation will especially be a factor in speeding or retarding the development process. Bristol Bay, as the most likely candidate for initial production, will depend on a marine system; icebreaking tug and barge combinations transferring oil to ocean-going tankers in the Aleutians offer an attractive method. Chukchi Sea transportation, although not expected in this century, will rely on icebreaking tankers.

--as discussed previously, tug and barge support traffic will reach substantial levels in 1983-84, and continue at fairly high tonnages as exploration and production activities continue. The level and timing of transportation buildups will be directly dependent on the pace of development activity, and will precede the production phase by several years. With sequential development similar to that illustrated in Figure 4-3, summer tug and barge traffic should continue with fairly high tonnage levels in the years following the Beaufort Sea lift.

--small boat traffic in offshore development areas will be directly proportional to the installation of drilling rigs.

Predicting the future of energy-related transportation, though it relies on the assumptions of energy development, is to some degree easier than energy forecasting. While the extent of producible oil and gas reserves are sketchy at best, and the combination of national and international

events affecting the oil industry are guesswork, arctic transportation alternatives are more clear cut. In general, marine transportation seems to offer the more attractive solution for support logistics and for moving the commodity. One aspect of this attractiveness has been alluded to: environmental considerations. These will be examined in the next chapter.

VI. CONCERNS FOR THE NATURAL AND SOCIAL ENVIRONMENT

"Environmentalism" is a rather recent addition to modern English. Moreover, the term is used loosely and is more a collection of connotations than a precise noun. It is used here to denote a concern not only for the land, flora and fauna in their natural states, but also for the established way of life and culture of certain social groups. Environmentalism can perhaps be viewed as the voice of the status quo inasmuch as it pertains to preserving systemic balance. The social context is less widely recognized, but it is an item usually required in environmental statements to ensure it is considered.

Environmentalism played such a central role in the development of Prudhoe Bay that a similar substantial impact is assured for any future oil and gas development in Alaska. It has, in fact, been involved in an ongoing debate that has recently reached a momentary lull with passage of an Alaska Lands Bill. The future influence of environmentalism will be felt on both of two issues already discussed: the pace and scope of energy development, and the transportation alternatives for moving oil and gas. Chapter IX will bring these relationships together in a more comprehensive manner.

A. THE ENVIRONMENTAL SETTING IN ALASKA

Spawned in the political turmoil of the 1960s, environmental consciousness came to particularly focus on crude oil when the tanker TORREY CANYON grounded on Seven Stones Reef in March 1967. The disastrous spill from this vessel was followed by a number of other tanker incidents and the demand for action reached a crescendo with an oil rig blowout in the Santa Barbara Channel in January 1969. The National Environmental Policy Act was passed the same year, the Environmental Protection Agency was formed in 1970 [Ref. 2], and subsequent legislation deeply involved the Coast Guard in marine environmental protection.

As has been mentioned previously, the TAPS debate centered to a large degree on transportation. Development of the Prudhoe Bay reserves was absolutely opposed in some quarters, but the political skirmishing largely involved the merits of oil transportation alternatives. The choice of an overland pipeline forced an immediate settlement of native land issues; and the Alaska Native Claims Settlement Act of 1971 included an innocuous 130-word paragraph which has become the vortex of what the Sierra Club labelled the "environmental battle of the century" [Ref. 94]. Section 17(d)(2) of the Act contained conservation provisions, among them an instruction to the Secretary of the Interior to choose for preservation 80 million acres from the public domain in Alaska "of sufficient interest to its national

owners" [Ref. 15]. These new national parks, wild rivers, wildlife refuges, and national forests were to be formed within seven years. In May 1978 a House-passed "d-2" bill failed in the Senate due to the threat of filibuster by Alaska`s Senator Mike Gravel. With the December 18 deadline nearing, Secretary Andrus, with White House backing, withdrew 56 million acres under the 1906 Antiquities Act and another 54 million acres of wildlife refuges. This move doubled the size of the national park system [Ref. 94].

During this process, the mood in Alaska grew steadily more hostile to the federal action. Most Alaskans cannot be described as environmentalists in the Sierra Club tradition, and the maneuvers in far-off Washington seemed high-handed and arbitrary. There was a real fear of exclusion from the land, that long established rights of hunting, fishing and access would be lost by Washington`s "lockup" of vast tracts, and that reasonable development of the state would be prevented.

In February 1980 the Senate again deferred the question. Andrus then withdrew another 40 million acres of wildlife refuges and put 12 million under temporary protection [Ref. 102]. However, on November 12 of the same year, a Senate bill was passed by the House and signed by President Carter. It contained the following provisons [Ref. 97]:

--added 43.6 million acres to the naional park system, doubling it in size.

--doubled wildlife refuge acreage by adding 53.8 million acres.

--tripled the national wilderness preservation system with 56.7 million acres.

--added 13 new wild and scenic rivers.

--speeded conveyance of 105 million and 44 million acres to the state and to natives, respectively.

--permitted limited oil and gas exploration activities on the William O. Douglas Arctic Wildlife Range.

Like the Pipeline Authorization Act, the Alaska National Interest Lands Bill is very much a compromise measure. The Alaska Coaliton, an alliance of 52 environmental groups, supported the legislation, but has identified "corrections" to be sought in 1981 [Ref. 111]. The forces of development are also unsatisfied. Exploration on the Douglas Wildlife Range, although allowed by the bill, is felt to be too restricted for the promise of this area; and some 154 million acres, or 41 per cent of the state, are further closed to normal oil and gas activity. Further legislative efforts on these items is also planned [Ref. 97].

While not completely resolving the problem of Alaska land use, the recent legislation at least provides a starting point for future debate about oil and gas development. Even so, the permissibility of oil and gas activities on the various land units will be the subject of debate. The industry will undoubtedly seek the broadest possible leeway for exploration; environmental groups will attempt to constrain oil and gas activity as much as possible. The

National Interests Lands Bill at least provides some starting rules.

Often overlooked in the development-conservation tug of war is the viewpoint of Alaska citizens. There is a great deal of ambivalence involved. Individuals, their state government and the local economy have benefited greatly from Prudhoe oil development, so much so that even by 1977 the state's per capita income was the nation's highest and 51 per cent above the national average. But there is also a concern for the uniqueness of Alaskan life. The 1974 election of Jay Hammond as governor represented hesitation about development [Ref. 15], and was reaffirmed by his defeat in 1978 of pro-development Wally Hickel. Yet 1980 brought the election of Frank H. Murkowski to the U.S. Senate, a man backed by out of state oil and business interests, to replace the more liberal Mike Gravel [Ref. 148]. Alaskans, as a group tend to be suspicious of oil companies, of "lower 48" environmental groups, and of the federal government. As a bumper sticker bluntly phrases it, "We Don't Give a Damn How They Do It On The Outside" [Ref. 94].

B. THE NATURAL ENVIRONMENT

For all of their inhospitality to the human race, the arctic regions are remarkable for their extreme fragility. Few human activities are more threatening to arctic natural systems than is oil and gas development. Oil industry

accidents will have a much greater effect on biota, land and water in the Alaskan arctic then elsewhere. This is due to weather conditions, geologic characteristics and biological susceptibility [Ref. 68].

Tundra, which comprises the land areas of the North Slope, is marked by extremely slow regeneration of any disturbance. Frozen in winter, the soil surface layer becomes wet and marshy in summer. Experience shows the principal environmental problems of oil and gas development stem from construction and overland transportation; bulldozer trails, for example, virtually become canals [Ref. 51]. One of the worst demonstrations of the tundra's fragility occurred in the 1960s when a Geophysical Service Incorporated bulldozer operator carved "GSI" and an arrow in letters 200 feet high. Thermokarst, or thermal erosion of the permafrost, was followed by slumpage, and now the scars are ponds eight feet deep [Ref. 15].

Technique can greatly reduce impact. Tundra damage is minimized by use of snow and ice roads in winter and with special tires for vehicles. Sand or gravel pads are necessary for construction areas such as drill sites. Careful avoidance of fuel spills and removal of waste are commonsense practices neglected in the past. One Geological Survey program in the National Petroleum Reserve-Alaska involves the rehabilitation of past excesses [Ref. 51].

Water areas are greatly affected by gravel dredging, although the severity of this type of bottom rearrangement is questionable. Much more threatening is the possibility of spilled oil in the cold and frequently ice-covered water. The problems include:

--oil spilled in the Arctic Ocean will be circulated by the Beaufort Gyral Stream over large areas.

--arctic conditons, such as low water temperatures and reduced wind fetch, will provide little weathering or dispersion for spilled oil. This will compound the possibility of environmental damage [Ref. 155].

--beside hindering clean-up efforts, ice and weather conditions could preclude the drilling of a relief well in cases of a blowout [Ref. 155].

--once trapped under ice for a season, oil will migrate upward through brine channels in the spring. On the ice surface, the dark color will accelerate melting. A large arctic spill could cause tremendous artificial melting of ice, and the long term effects of this, though not proven, could involve climate changes and an upset of the global heat balance [Ref. 17].

The Coast Guard has conducted a number of studies [Refs. 32, 43, 63] to identify the effects of oil spills and assess cleanup methods, and other extensive research has been done both in this country and abroad. On the whole, equipment and knowledge do not appear to be at a stage of maturity necessary for adequately handling a large arctic spill.

The effect of development activity on wildlife probably qualifies as the most hotly contested environmental issue. An ARCO study conducted from 1969 to 1979 found the development around Prudhoe Bay to have had no effect on wildlife: caribou and snow geese both maintained stable

populations [Ref. 115]. Nonetheless, there is real concern that as activity expands, wildlife will inevitably suffer. The many species inhabiting or visiting the Douglas Wildlife Range and bowhead whales in the Beaufort Sea are directly in the path of progress.

The arctic is biologically important because many of the indigenous and transient ecosystems have global significance. Disruption of special areas or conditions unique to the arctic could seriously affect ecosystems in other parts of the world. As an example, high nutrient areas support hundreds of thousands of animals and birds during breeding seasons or at a vital stage of long-ranging migrations [Ref. 81].

Even the presence of unnatural sound can adversely affect wildlife. Research indicates that marine mammals rely exclusively on auditory sensations for long range orientation and communication. A large tanker could raise ambient noise levels by 40 decibels at 100 kilometers. Little conclusive data exists, but this could seriously disrupt the lives of a variety of marine mammal species [Ref. 96].

The problem is exacerbated by a lack of reliable information. It is dificult to make intelligent choices concerning environmental-development tradeoffs when little is known of natural ecosystems and the effect that certain activities will have. But the interest in developement of Alaska has prompted much new research. The National Oceanic and Atmospheric Administration (NOAA) has, for example, an

ongoing outer continental shelf environmental assessment program, which has been expanded to the Bering Sea at Bureau of Land Management request. The objective of the program is to develop information and data bases on biological, physical, chemical and geological processes; this will improve ability to assess and predict the impact of oil and gas development. Of especial interest are [Ref. 28]:

--pollutant effects

--naturally occurring oil seeps, which are estimated to account for ten per cent of all marine hydrocarbons. Marine transportation introduces 35 per cent, offshore oil activity 1.3 per cent, and the remainder comes from runofff, fallout and coastal facilities.

--hazards imposed by the environment on petroleum exploration and development activity.

It is clear, as one Canadian report phrases it, that "research results and data alone are not enough to define policy; but good policies for resource management cannot be developed in the absence of knowledge" [Ref. 81]. The adequacy of the current body of information is, of course, subject to debate. The choices would be difficult ones even with perfect knowledge of cause and effect relationships.

C. SOCIAL AND NATIVE CONCERNS

Leading a tough and remote existence with few interests that coincided with those of civilization, Alaska's natives were largely ignored until the Second World War. Most of the various native cultures had no concept of land ownership, but claims began to be heard in the 1960s as natives saw acreage

pass to state control and for geologic exploration [Ref. 15]. Native groups found sympathy in federal courts and in the higher levels of the Interior Department. The 1971 Alaska Native Claims Settlement Act has been previously cited and was truly a piece of landmark legislation. The effects included [Ref. 15] :

--transfer of 40 million acres and $1 billion to natives.

--opening the way for TAPS and Prudhoe Bay development.

--conservation measures that sparked the ten-year Alaska lands battle.

--changing forever the status and structure of native societies, by instituting a system of native corporations as vehicles for political power and tangible wealth.

The twelve native corporations are oriented along geographic and ethnic lines, with a thirteenth for natives residing outside of Alaska. These organizations wield real power. With the resources to buy first-rate financial and legal expertise, the corporations have invested both in and out of the state. Yet alongside the demands for economic participation in Alaska, there is also a strong force for preservation of traditional culture and values [Ref. 15].

Civilization has brought many conveniences to the native in the "bush," but these have been accompanied by the scourge of alcoholism and have fostered dependence and alienation. A return to older ways, or even a synthesis of traditional and western values, will in one respect be manifested as a desire to ensure long term integrity of the land and wildlife.

This trend is perhaps best exemplified by attempts of the North Slope borough to restrict certain areas for subsistence use only (see Chapter IV). How sucessful the borough's 5000 inhabitants, mostly natives [Ref. 126], will be is in question.

Those involved in commercial fishing also find threatening aspects to energy development. A great deal of fishing in Alaska is done from small family-owned boats, with a substantial investment risked each year on the vagaries of the catch. Fishermen are generally opposed to marine aspects of the oil industry; this concern has been reflected in the past as TAPS tanker restrictions in Prince William Sound and the withholding of Bristol Bay tracts from lease.

Natives are not the only Alaskans who subsist on the land. The vastness of the state embraces many people who, for various reasons, have sought a wilderness lifestyle and live primarily by subsistence activities such as trapping, fishing and hunting. Many lived for years on the public domain before the land was classified into "use" categories, and it is these "squatters" who are most threatened by recent events in Alaska. With much of the land now parcelled into parks, refuges and wilderness, or in the process of transfer to state and native control, many people are finding their living arrangements in violation of the law. Unlike the natives, these people have no organizations to represent and protect them. But their ideals are shared by many Alaskans,

most of whom are involved to some degree with wilderness activites even if they do not take their livelihood directly from it. There is, therefore, a significant political force that will oppose development activity insofar as it is perceived as being destructive of certain ways of life.

"Social" environmentalism cannot be separated from "natural" environmentalism. Many of Alaska's inhabitants depend heavily on the stability of natural ecosystems, whether for economic, cultural or recreational reasons. Disruption of these systems or the natural setting in which they exist would seriously affect the local economy and social structure [Ref. 81]. The rights of those living close to the land or the sea will have to be accounted for in development decision making.

D. ENVIRONMENTALISM AS A COUNTERFORCE TO DEVELOPMENT

The development of Prudhoe Bay and the Trans-Alaska Pipeline were an introduction to subtle changes in America's collective notion of "progress;" the level of opposition and the arguments hurled at TAPS were new, and undoubtedly would not have been issues 20 years before. The environmental viewpoint is generally seen as a "yes, but ... " approach, a negative restraint on human endeavor. It will act in much this same vein as it meets the next wave of oil and gas development in Alaska.

The nature of the conflict will not be a simple conservation-development dichotomy. Instead, it can be better characterized as the interaction of a triad of interests, representing

--development: the commercial interests of the oil industry with the backing of like-minded Alaskan individuals and organizations.

--conservation: national environmental groups, mostly from outside Alaska.

--local use: natives, "subsistence" Alaskans, and others depending directly on the natural environment.

The sides and positions in this three-way contest are fluctuating. The Sierra Club has expressed satisfaction with the environmental features of TAPS since it has been in operation. Many of the native corporations are involved in enterprises that stand to gain from further development in Alaska, and some are partners in oil and gas development itself. Three corporations have joined VECO, Inc., to produce the first Alaskan-built drilling rig [Ref. 100], and some December 1979 Bering Sea leases are owned jointly by native groups and oil companies.

Notably absent from the triad of interests is government. Federal agencies are spread across the spectrum. Land management organizations, for example, range from the Park Service which is dedicated to the ideal of preserving land as it is, to the Fish and Wildlife Service which travels a middle road seeking compatible use, to active support of economic exploitation by the Forest Service and Bureau of

Land Management [Ref. 15]. The Alaska state government is similarly fractionated as it attempts to represent the diversity of interests within the state.

Development will inevitably mean disturbance of the natural environment to some degree [Ref. 51]. Operations on the tundra demonstrate this; and it has been estimated that for every one million barrels of oil produced in the Beaufort Sea, two hundred barrels will be spilled into the water [Ref. 93]. For this reason, the environmental side will always have an edge, the benefit of doubt. Resources preserved in their natural state can always be developed in the future, but once developed the process can rarely be satsfactorily reversed.

In summary, environmental concerns will influence the future of arctic Alaska in the following ways:

--the choices will not be clear cut selections between virgin wilderness and the ravages of all-out development. Instead, the outcome will be one of compromise along the lines of the TAPS model. Environmental groups will not seek (or be able) to stop development, in recognition of the overall energy reality.

--environmental concerns will act as a restraint on development actvities by insisting on the use of minimally destructive methods and inclusion of adequate safeguards in projects. Again, this follows the TAPS precedent. In addition, there will be a thrust to limit the scope of development in areas of special circumstances, using the framework of recent Alaska lands legislation.

--following precedent, a principal tactic will be the use of lawsuits to stop development, slow it down or effect compromises.

--development of the Bering Sea and Chukchi Sea offshore tracts and the deeper Beaufort Sea waters will face more

restraints from technological and logistic problems than from environmental pressure. Bristol Bay will be the exception in these areas.

--environmental forces will strongly resist development of the Douglas Wildlife Range and Bristol Bay, but in the end will succeed in limiting and modifying development activity rather than preventing it in these areas.

Environmental advocacy is brought into the decision process as a required part of environmental statements; this ensures that concerns of the social and natural environment are at least recognized. Somehow, the political system must decide on relative values: whether a barrel of oil from the Alaskan arctic is worth incremental disruption of existing social and ecological systems, and whether that barrel of oil has greater value now or in the future. The choices are long term, complex and uncertain.

VII. CANADIAN ARCTIC DEVELOPMENTS

For all the prospects, potential and optimism that surrounds oil and gas development in arctic Alaska, the setting is a rather tame one compared to events unfolding in the Canadian arctic. Canada's 80 degree arc of arctic frontage is second only to that of the Soviet Union. Over the past two decades there has been a growing awareness of the once-ignored northern lands by both the Canadian government and the private sector. Development of Prudhoe Bay stimulated exploration on the other side of the border, and the pace of activity now underway in Canada may well have a similar accelerative effect on American arctic efforts.

The importance of arctic marine transportation has long been recognized as key to development of Canada's inaccessible northern territories. A sizeable, though not overwhelming icebreaker fleet is maintained by the Canadian Coast Guard, as shown in Table 8-1. Commercial transport was greatly advanced by the 1978 completion of MV ARCTIC, a 28,000 deadweight ton class II icebreaking freighter. Built with substantial government assistance at a cost of $38 million, the ARCTIC is intended for high latitude use from June through November. This will be supplemented by cargo carriage in the Great Lakes, occasional voyages to Europe, and grain export from Churchill, Manitoba, in Hudson Bay

Figure 7-1:
The Canadian Arctic

[Ref. 141]. The ARCTIC is also used in transporting lead and zinc ore from the Strathcona mine on Baffin Island, and is guaranteed half of the output from similar mining scheduled to begin on Little Cornwallis Island in 1982 [Ref. 140]. Canada's first significant attempt at arctic commercial shipping will undoubtedly find ample work [Ref. 147]. It will also break the ice, both literally and figuratively, for more ambitious transportation technologies.

Canadian arctic development projects planned or in motion, and their potential influence, are described in the following sections.

A. DOME PETROLEUM AND THE BEAUFORT SEA

Occupying a premier position in arctic energy development, Dome Petroleum Ltd is a 30-year old company and the largest oil and gas landholder in Canada [Ref. 46]. Dome drilled its first well in the high arctic in 1961 [Ref. 44]. With 1979 revenues of $804 million and $154 million in net income [Ref. 151], the company was about 50 per cent Canadian held in December 1980 [Ref. 87]. As a publicly traded corporation, ownership fluctuates; the significance of Canadian control in an increasingly nationalistic political setting will be discussed later in the chapter.

While involved in numerous geographic areas, Dome's primary arctic venture is in the Canadian sector of the Beaufort Sea. The company estimates that 30-40 billion

barrels of oil and 250-320 trillion cubic feet of gas lie in the Beaufort-Mackenzie Delta structural traps [Ref. 105], with a 25 per cent chance of a 70 billion barrel oil potential [Ref. 118]. The president of the company has predicted that half of Canada's oil will come from the Beaufort by 1990 [Ref. 108]. Annual drilling expenditures are in the $150-200 million range [Ref. 118]. There have been encouraging successes: oil or gas has been found in all of eight wells drilled to 6000 feet [Ref. 151].

Dome plans to begin production by 1985, and have 1.5 million barrels per day (equal to current Prudhoe Bay production) flowing by 1995 [Ref. 108]. To achieve this, however, some severe technological obstacles must be surmounted. Much of Dome's activity is in the shear zone, or area of seasonal ice formation, which is marked by dynamic and rapidly deforming ice conditions [Ref. 155]. The Beaufort Sea bottom is ice-scoured to a depth of 130 feet, the permafrost is discontinuous, and the sedimentary bottom is unstable [Ref. 17]. Additionally, Beaufort Sea oil deposits are probably in small pools [Ref. 76]. There is avid curiosity about the type of production facilities the company will use in the ice-wracked Beaufort. Reinforced sand and clay "atolls" may be built in 200 feet of water; the first will take three or four summers to build and cost $1 billion [Ref. 151]. One possible alternative is the use of monocone platforms capable of withstanding the forces of ice

in water 150 to 250 feet deep. The structure rests on the bottom, and has curved sides which force the ice to bend upward and break [Ref. 76]. Moveable concrete or steel caissons for storage are also under consideration [Ref. 105].

Dome is not revealing its exact plans, except that the operation will be monstrously expensive. An independent source estimated that drilling costs per foot from an artificial island will be 10-15 times the cost of a typical conventional well in Alberta; and from a drillship will be over 40 times as much [Ref. 76]. To get two billion barrels of oil from the Kopanoar field alone will require an investment of $5 billion [Ref. 151]. Nonetheless, there is some evidence--subject to the errors of estimation--that Beaufort Sea oil can be delilvered to southern Canada at costs equal to or below those of imported oil at its 1980 price [Ref. 76].

Transportation represents an even more intriguing technological hurdle. Dome plans to move its extracted crude oil with a pair of 200,000 deadweight ton class X icebreaking tankers [Ref. 105], each with 150,000 shaft horsepower [Ref. 78]. To contribute to the design of these vessels and prove the feasibility of year-round operation [Ref. 147], Dome has embarked on a research program centered around the CANMAR KIGORIAK. This prototype vessel has the following characteristics [Ref. 5]:

--6500 tons.

--300 feet in length, overall.

--16,400 shaft horsepower to a single propeller.

--a spoon-shaped bow to minimize icebreaking energy loss.

--a mid body reamer, providing better turning capability.

--bow and stern thrusters for maneuverability.

--a water spray system on the bow to provide lubrication.

Constructed in nine months, the KIGORIAK attempted for her first voyage to make a particularly challenging late season transit of the Northwest Passage as 1979 drew to a close. Her performance exceeded expectations. It was especially notable since the Canadian Coast Guard's new R-class icebreaker, the FRANKLIN, also on her maiden voyage, lost all the blades on one propeller and became beset in Viscount Melville Sound; FRANKLIN and the assisting ST LAURENT had to return to eastern Canada via the Panama Canal [Ref. 147]. It was, to the Canadian government, an embarrassing comparison of public and private icebreaker capabilities.

Dome currently owns 17 other ice-capable vessels, including four drillships [Ref. 105]. It is also developing a "swivelship," able to rotate as it encounters passing ice, without disrupting the drill string. The cost of such a vessel will probably be about $100 million [Ref. 151].

The company appears to be proceeding energetically toward development of an arctic marine transportation system. A recent announcement outlined plans for a $250 million

shipyard, to be built for construction of ice-strengthened ships. Conventional liquified natural gas (LNG) carriers will be produced initially, with construction of Beaufort Sea tankers to follow [Ref. 156].

Dome Petroleum seems determined to see oil flowing from the Beaufort Sea. Its success in the endeavor will represent a quantum leap in the technology of arctic hydrocarbon development. More worrisome than the engineering problems, however, are shifting political winds in Ottawa. As will be discussed in the third section of this chapter, government controlled oil prices and tax policy are the real keys to Dome's success in the Beaufort.

B. ENERGY IN THE ARCTIC ISLANDS

Geographically, the higher latitudes of the Canadian arctic consist of an extensive archipelago, laced with waterways that are covered with ice much of the year. The forbidding surface conceals a subterranean geology that is attractive prospecting territory for oil and gas. While Dome pursues oil in the Beaufort Sea, significant energy development movements are also underway in the high arctic.

Panarctic Oils Ltd, 45 per cent government owned [Ref. 95], is perhaps foremost in island exploration technique. The company estimates that 60 trillion cubic feet of gas can be proved in the arctic islands [Ref. 105]. Its Drake F-76 well, completed in April 1978, was the first arctic offshore

well to produce gas in commercial quantities [Ref. 144]. A Panarctic specialty is the use of ice floes for drilling. 22 ice platforms have been built up with pumped water; they require reasonable stability of the ice sheet, but rollers allow lateral movement of the derrick up to 4.5 meters [Ref. 85]. Panarctic has improved the technique by use of urethane blocks to reduce weight on the floe and speed construction [Ref. 145]. Flowlines to shore are buried to afford protection from ice scour [Ref. 144]. In water 55 to 400 meters deep, the ice platform approach has shown itself to be the least expensive alternative [Ref. 85].

Panarctic is the lead company in the Arctic Island Exploration Group which was formed in 1976. Other partners include Esso Resources Canada, Gulf Oil of Canada and Petro-Canada (with an 18 per cent share). The purpose is to acquire oil and gas rights in the Sverdrup Basin, a 500,000 square mile geologic area which includes much of the Canadian archipelago. Panarctic and its partners had spent $180 million on seismic work and drilling by early 1980 [Ref. 105].

The most ambitious high arctic undertaking is the Arctic Pilot Project, a joint effort which includes state-owned Petro-Canada (with a 37.5 per cent share), Dome Petroleum (20 per cent), as well as Nova, Melville Shipping, and Alberta Gas Trunkline Company [Ref. 136]. The project touches almost every aspect of arctic oil and gas development: drilling, pipeline construction and employment of a fleet of

icebreaking tank vessels. The purpose is to test the economic and technological feasibility of energy development and the marine mode of transportation, at the minimum scale necessary to prove it [Ref. 65].

Gas will be extracted from eight wells at Drake Point on Melville Island [Ref. 105]. It will be brought to Bridport Inlet on the island's southern coast for liquifying, storage and loading, via a 161 kilometer buried pipeline. From this point a pair of icebreaking liquified natural gas (LNG) carriers will make deliveries to a terminal in eastern Canada. These 1100-foot ships will have turbo-electric power plants driving three propellers [Ref. 65], and will cost an estimated $530 million each [Ref. 136].

In comparison with Dome's crude oil tankers, the LNG carriers will be narrower, and because of the lightness of natural gas, will have half the displacement and draw less water. This latter characteristic exposes the propellers to greater hazards from ice and makes them less efficient. It also gives the ship less icebreaking ability: in spite of one-third more power, they will be rated as class VII where Dome's tankers will be class X [Ref. 65].

With heavy government involvement, the Arctic Pilot Project reflects concerns which go beyond normal commercial objectives. In addition to providing 225 million cubic feet of gas to Canadian consumers each day, the undertaking is designed to [Ref. 65]:

--enhance defense efforts.

--provide economic activity for both northern and southern Canada.

--move Canada to the technological forefront, especially in the commercial icebreaking field.

--spur development of northern territories.

The Arctic Pilot Project is in some ways more ambitious than Dome's pioneering efforts in the Beaufort Sea. The $1.7 billion project has had its target date for beginning operation slipped from 1983 to 1985 [Ref. 105], and even the extension seems optimistic in view of the project's scope. But talks with Newport News Shipbuilding and Drydock Company began in mid 1980, concerning construction of the LNG tankers [Ref. 116] and all indications point to its continuation.

A similar project has been proposed for exploiting gas resources in the vicinity of Ellef Ringes Island. Trans-Canada Pipelines Ltd, of which Dome is the principal shareholder, is studying the plan, which would involve transportation of the gas in three 75,000 ton class X icebreaking LNG carriers. It has been stated that there would be no competition with the Arctic Pilot Project [Ref. 136].

Taking a different approach to the transportation issue is the Polar Gas Consortium. Consisting of Panarctic, Trans-Canada Pipelines, Tenneco, Petro-Canada and Ontario Energy Corporation, the consortium began planning a gas pipeline from the arctic islands in 1972. The Y-shaped line would bring gas from the Mackenzie Delta as well as from the

islands. The hope is to have the system in place by the late 1980s [Ref. 105]. With all the disadvantages of pipeline construction, the project appears to have somewhat less momentum than the marine alternatives.

C. THE POLITICAL SETTING

The Canadian energy industry is marked by more government involvement than is suffered by its American counterpart. Much of this difference derives from a desire to protect Canada's considerable energy resources from domination by foreign interests. Foreign control is not a hollow issue: 19 of Canada's top 25 producing companies [Ref. 106], and 72 per cent of the entire oil and gas business [Ref. 137] are foreign controlled. The result of this political sentiment is a steady stream of often conflicting signals which the private sector must interpret, and a more volatile environment in which to operate.

The duality of government cues is illustrated by the following example. In 1977 a "superdepletion" allowance was introduced, permitting companies such as Dome to write off 200 per cent of exploratory costs. This provision expired in March 1980, reverting to a 133 per cent level, and has been the source of much uncertainty for companies operating in Canada [Ref. 151]. Tending to nullify the supportive nature of superdepletion are price controls which have kept Canadian oil prices at roughly half of world rates [Ref. 151]. This

has naturally tended to hold down production and puts Canadian government policy moving in an opposite direction from that in the U. S.

On the whole, however, Canadian government policy has been generally favorable to northern energy development. When Dome made its large Beaufort Sea strikes in 1979, Canadian domestic reserves had fallen for the tenth consecutive year and arctic resources represented an attractive solution. Yet the picture has been complicated by prospects of offshore oil in the Grand Banks of Newfoundland. With this area's proximity to consuming markets and fewer technological problems to overcome, priority could conceivably shift away from the arctic [Ref. 79].

Canadian government involvement is most conspicuous in its ownership of Petro-Canada, formed in 1975. An expanded role for the state owned company is one key element in the Trudeau government's new national energy policy announced in October 1980 [Ref. 106]. Other items included:

--government appropriation of 25 per cent of oil company reserves [Ref. 87].

--guaranteed pretax margins of 38 per cent for oil and 47 per cent for gas [Ref. 87].

--incentives for reducing oil demand and substituting gas [Ref. 114].

--"Canadianization" of the industry, with a goal of 50 per cent Canadian ownership by 1990 [Ref. 114].

--a system of cash grants which could reimburse up to 80 per cent of exploration costs.

--formation of a National Petroleum Agency, which would control production and sale, establish a national marketing system, compel private production in emergencies, and administer incentives for Canadianizing the industry [Ref. 118].

Industry reactions to the policy were understandably negative, though varied. By December 1980 a trend toward reduced capital budgets and postponed projects was noted; and an exodus of drilling rigs to a more lucrative exploratory environment in the U. S. was underway [Ref. 107]. Dome Petroleum voiced concern for the viability of its Beaufort Sea operations, and labelled Trudeau's policies as "highway robbery" and "confiscation." The market value of Dome stock fell more than 20 per cent in the two days following the budget message [Ref. 87]. Nonetheless, Dome may increase its Canadian ownership to 75 per cent to qualify for extra exploration rights in frontier areas [Ref. 122].

Imperial Oil, the largest integrated oil company in Canada with $5.6 billion in revenues, was more sanguine. As a 70 per cent owned subsidiary of Exxon, the company acknowledged that it is a prime target for nationalization, but admitted to no plans for significant withdrawals or reduction in its Canadian activities [Ref. 86].

The after effects of the new government policy will reverberate in a complex political setting. Canada imports 500,000 barrels of oil per day [Ref. 103], which is primarily consumed in the eastern provinces. The western producing provinces, and especially Alberta, feel more affinity for U.

S. policies and are bridling under the price controls and other policies set in Ottawa [Ref. 106]. Alberta has threatened to cut back production by March 1981 if negotiations with the federal government do not move in a favorable direction [Ref. 120]. The issue is so divisive that it threatens the very foundations of the Canadian federation.

Bureaucracies within the Canadian government itself have differing goals and alignments with respect to the development issue. The Department of Energy, Mines and Resources (DEMR) generally sides with the environmentalist camp, while the Department of Indian Affairs and Northern Development (DIAND) has a pro-growth orientation. These agencies are constantly at loggerheads. Since both have extensive responsibilities in the Canadian arctic, the lack of centralized planning and decision-making interjects an added element of political uncertainty [Ref. 175].

The problem extends to Canadian icebreaking as well. Even with a number of innovative marine transportation products under development the Department of Transport has made the determination not to react to arctic oil discoveries or potential marine transportation through the Northwest Passage. The new R-class icebreakers have been criticized for adding no significant polar capability to the fleet, and in reality would be of little assistance to arctic commercial shipping [Ref. 147]. The icebreaking policy is perhaps

indicative of government ambivalence toward arctic development.

Canadian arctic development has been no less affected by environmental considerations than have development proposals for Alaska. There is a similar three-way confrontation between developers, local users and protectionists [Ref. 81]. Canadian natives have grown restive as oil and gas exploration has intensified, and this is being acknowledged by government and industry. Dome, for example, employs natives as 20 per cent of its arctic work force [Ref. 151], and the Arctic Pilot Project has been planned to employ northern residents but cause minimal disruption of their communities. Liaison and participation of northerners in the development process have been major points of emphasis [Ref. 66].

Dome's plans for deep water Beaufort Sea drilling caused a great deal of concern, especially with respect to the possibility of a well blowout during exploratory drilling. A joint government-industry undertaking, the Beaufort Sea Project, was an innovative means of developing constraints for drilling. The U. S. State Department reacted to the findings with a "note of concern;" oil from a Canadian blowout would be carried by the Beaufort Gyre into Alaskan waters and swept onto the North Slope shoreline. Drilling activity was eventually approved by the Canadian cabinet, but

with a number of precautionary conditions [Ref. 155]. These may be seriously undercut, however, by a shortage of qualified government inspectors [Ref. 79].

The Beaufort Sea Project and other research efforts have made headway, but because of the vastness of the Canadian arctic, there are large information voids [Ref. 81]. The Arctic Pilot Project in particular has been subject to lengthy environmental review, perhaps because of government participation in it. Petro-Canada is planning to commit $10 million annually for 20 years on technical research and monitoring studies [Ref. 90]. Of particular concern is Lancaster Sound, an area of unusual biological productivity and a major channel for eventual arctic tanker traffic. The effects of an LNG tanker passing every six days has been the subject of much debate. As in Alaska, Canadian environmental concerns will undoubtedly cause modifications but do not promise to seriously inhibit Canadian arctic development efforts.

One early response to the environmental threats of arctic marine transportation was the 1970 Canadian Arctic Waters Pollution Prevention Act. Prompted by the MANHATTAN operations, the legislation places stringent standards for design, construction, navigational procedures and equipment, pollution liability, fuel and water quantities, and bunkering stations for commercial ships operating in the Canadian arctic. There are shipping safety control zones, and speci-

fications as to the class of ice capability allowed in each zone at various times of the year [Ref. 139]. An "ice navigator" is required for each vessel, although this qualification is satisfied by five days operating experience in the ice [Ref. 91]. The Act is reflective of the serious issue of sovereignty which has arisen from recent events in the arctic; this will be discussed more fully in Chapter VIII.

D. SPILLOVER: EFFECTS ON ALASKAN DEVELOPMENT

It is appropriate at this point to examine the relationship of Canadian arctic developments to the future of arctic Alaska. The principal effect will be a technological "pull" on Alaskan development, resulting from engineering breakthroughs and proven arctic techniques. These will involve arctic drilling, storage and production methods, especially the deep water Beaufort Sea operations of Dome Petroleum; and as importantly, the marine systems which will transport energy resources to user markets. Successful Canadian projects will greatly reduce risk, lower costs and make similar development projects in arctic Alaska more attractive. The operative word, of course, is "successful." If current Canadian plans are carried through, the country will be the world leader in arctic energy development by the end of the decade.

One other factor will have ramifications for Alaskan energy development and wider issues as well. An agreement

between Japan National Oil Company (JNOC) and Dome Petroleum was concluded in mid 1980, involving a JNOC loan of $400 million to finance Beaufort Sea development efforts. The main intent of the Japanese company was to obtain rights to Canadian oil; under the agreement, JNOC will receive a share of production in proportion to the share of development costs it financed. There is no guarantee, however, that the oil can eventually be exported to Japan, since this would require approval by the National Energy Board and Canadian government certification that the oil is in excess of Canada's needs. But even if export is disapproved, JNOC could market the oil in Canada [Ref. 117].

The Dome-JNOC agreement is significant because it raises the very real possibility of a marine transportation system carrying Canadian oil through the Bering Sea. There is an inherent logic in the distances involved: Japan is 4000 nautical miles from the Beaufort Sea and 8000 from the unstable Persian Gulf [Ref. 46]. The Japanese have indicated a willingness to invest up to $2 billion if development of the Beaufort Sea fields proceeds [Ref. 117]. In late 1980, Chubu Electric and Nissho-Iwai were negotiating with Dome for natural gas supplies; while this particular transaction will probably involve export from a terminal north of Vancouver [Ref. 117], there appears to be ample potential for the use of Japanese capital in developing Canadian arctic resources. Given the arduousness of marine transport to eastern Canada

and lack of a need for oil and gas in the western provinces, an international Point Barrow-Bering Strait-Unimak Pass transportation corridor is a real possibility.

An overview of Canadian arctic developments provides the following outlook:

--in view of the heavy investment already committed, government involvement, and a head start, arctic development projects will not be seriously disrupted by Grand Banks prospects.

--Dome Petroleum will have commercial production from Beaufort Sea wells by the end of the decade. The oil will be moved in icebreaking tankers.

--Beaufort Sea oil appears likely to be exported in some quantity to Japan. Imports will still be necessary in eastern Canada by the time Beaufort production comes on line, and this will be a political factor working against export. However, the Bering Sea route represents a more reasonable marine transportation alternative and difficulties may be solved by Japanese-supplied oil to the Atlantic coast. In the long term, offshore east coast production may also solve the problem.

--the Arctic Pilot Project will move into operation, aided by government participation and subsidiary national objectives. The 1985 target date seems likely to slip. The LNG will be moved by icebreaking tankers.

--the pace of Beaufort Sea and other arctic development efforts will depend on incentives or disincentives imbedded in government policies. The current government presence and nationalistic sentiment make this factor even more significant that is the case for arctic Alaska.

--Canadian results will stimulate the Alaskan energy scene as previously noted. Dome's Beaufort Sea efforts are most relevant; success there will enhance the attractiveness of developing the offshore Alaskan Beaufort and the Bering Sea provinces.

The ambitious projects underway in Canada have yet to prove their efficacy, but they represent two potential

sources of influence on the U. S. These are the technological leadership "pull" and the impact of foreign ship transits through American coastal waters. While the former factor will affect the energy development process in arctic Alaska, the latter will have a direct impact on the Coast Guard and its icebreaking role. It will be further discussed in Chapter IX.

VIII. THE INTERNATIONAL PERSPECTIVE

The arctic's geographic centrality has been long unrecognized, a victim of cartography's representation of the world. The usual Mercator projection leaves only a peripheral (and greatly distorted) margin of arctic land and water, and undoubtedly this presentation has been as responsible for the arctic's general neglect as have its forbidding characteristics. More realistically, however, the arctic is the geographic center of the northern hemisphere and therefore of most of the earth's land mass, population and economic wealth. A polar projection or a globe demonstrates this reality (see Figure 8-1).

International interest in the arctic is on the ascent, and this is due principally to the successes of applied knowledge. The advent of technology is steadily reducing the arctic's effectiveness as a barrier to a wide range of human activities. Development of energy resources, the focus of previous chapters, is currently foremost among these activities. But the demise of the arctic as too forbidding to be relevant brings the area increasingly into the realm of international affairs.

A. SOVEREIGNTY ISSUES

International law, developed over the centuries in more

Figure 8-1:

The Arctic Center of the Northern Hemisphere

temperate latitudes, has been found wanting in recent applications to developing arctic issues. Sovereignty is perhaps the prime concern. Driven by the promise of vast new resources, the problem of ownership rights has emerged with a number of features unique to this part of the world. Ongoing Law of the Sea negotiations are resolving many of these issues, but many complications remain.

Should ice, for example, be regarded as "water" or as "territory?" Drifting ice has been cited as a basis for questioning classification of the Arctic Ocean as high seas [Ref. 5]. The permanence of much of the arctic's ice and the fact that it is often as passable as land gives a great deal of credence to the territorial description. But this would seemingly open the Arctic Ocean's huge ice pack to colonization, and does not resolve the problems of its constant movement. If, on the other hand, movement disqualifies permanent ice as land, is a grounded ice island to be regarded as territory? Do semi-permanent ice research stations, which move with the pack, have the same legal status as ships? Although there are no clear cut answers, international legal practice currently tends to ignore temporary ice coverage but takes some cognizance of permanent ice for the purposes of sovereignty [Ref. 69]. The issue is far from fully resolved.

Territorial claims in the arctic are noteworthy. There is a general lack of agreement on coastal state jurisdiction

over arctic seas [Ref. 5]. The previously mentioned dispute in partitioning the Beaufort Sea between Alaska and Canada is one reflection of this. Potentially more serious is the Norwegian-Soviet controversy over their continental shelf boundary and rights to Svalbard (Spitsbergen) resources. A lack of resolution of this problem has contributed to the lag in oil exploration in the European arctic.

Canada in 1925 laid claim to all lands and islands, known or yet to be discovered, lying in a sector described by the North Pole, the 141st meridian west of Greenwich, and a point equidistant from the coasts of Ellesmere Island and Greenland. In the following year the Soviet Union made a similar sector claim, and acknowledged the existence of four other sectors of sovereignty belonging to Canada, Norway, the U. S. and Denmark (by virtue of its ownership of Greenland) [Ref. 69]. However, the Soviet press has also voiced claims to the ice, water and air space within their sector. Since the sector principle has no basis in international law and has never been litigated in international courts, it offers little firm guidance [Ref. 5]. The official positions of the United States, Denmark and Norway have maintained that arctic waters beyond a territorial sea belt are, as in other parts of the world, high seas; and that this is irrespective of ice cover. Canada has leaned to this view, but perhaps somewhat more so to the concept of the arctic as a special sovereignty problem [Ref. 69].

The status of arctic waterways is at the center of the sovereignty question, for in this respect it is more than a technical legal issue. The future of commercial arctic marine transportation will depend to a large degree on the right of transit through waterways such as the Northwest Passage and certain straits in the Russian arctic. The Soviets have declared the Kara, Laptev and East Siberian Seas to be internal waters, and have designated their Northern Sea Route a "national route," presumably excluding uninvited foreign use [Ref. 69]. U. S. icebreaker probes were made by the NORTHWIND in 1965 and the EDISTO and EASTWIND in 1967. In addition to conducting scientific research, the ships were attempting to transit the Northeast Passage. They eventually turned back rather than challenge strong Soviet opposition [Ref. 69]. The Canadians are similarly, though perhaps not so xenophobically, concerned about the Northwest Passage. It appears to be much closer to routine commercial use.

A crucial issue is whether such waterways are "international straits," where freedom of passage is identical to that on the high seas. Under the test utilized by the International Court in the Corfu Channel case of 1949 (ICJ. Rep 4), a strait must have been a useful route for international maritime traffic to meet the definition. Since the Northwest Passage has had only about 25 complete crossings since Amundsen's initial transit, and the six foreign crossings were all with Canadian sanction, this

particular waterway is therefore not an international strait by the Corfu Channel definition. [Ref. 139].

However, even if the Northwest Passage were to become an international strait, the right of imposing special pollution requirements would remain. The Canadian delegation to the Law of the Sea Conference pressed hard for the insertion of a so-called "ice-covered area" provision. It reads as follows:

> Coastal states have the right to establish and enforce non-discriminatory laws and regulations for the prevention, reduction and control of marine pollution from vessels in ice-covered areas within the limits of the exclulsive economic zone, where particularly severe climatic conditions and the presence of ice covering such areas for most of the year create obstructions or exceptional hazards to navigation, and pollution of the marine environment could cause major harm to or irreversible disturbance of the ecological balance [Ref. 139].

This clause was inserted in the Negotiating Text of 1976 and has survived intact in the 1977, 1979 and 1980 revisions. In essence, it validates the Canadian Arctic Waters Pollution Prevention Act of 1970 and has received wide support, including that of the United States which had strongly opposed the 1970 legislation [Ref. 139]. In the opinion of a Canadian professor of international law, the "ice-covered area" clause may now be regarded as a part of customary international law [Ref. 139].

The issue may become an important U. S. concern as well. with foreign tankers regularly plying the coastal waters of Alaska, concern for the environmental integrity of these areas will arise. The "ice-covered area" clause will provide

a vehicle for instituting and enforcing environmental rules for foreign shipping.

Transportation thus appears to be the most immediate focus of the arctic sovereignty debate. The Canadian response to commercial arctic traffic seems to be an even-handed and reasonable one, permitting innocent passage with suitable provisions for control of environmental damage, within the context of international agreement. The Soviet response to similar issues will be more interesting.

B. THE SOVIET UNION AND THE ARCTIC

More so than any other nation, the Soviet Union is an arctic land. It spans almost half of the land arc fronting the Arctic Ocean. Soviet Communism has reinforced a historic northern orientation: development of northern resources, promoting larger populations and installing the necessary logistic systems have been recurring items in Soviet five year plans.

Resource exploitation in particular has been a relentless goal, and the Soviet Union has been far more active in developing resources than any other arctic nation. This has often been done at enormous cost, to achieve self-sufficiency and satisfy socio-political objectives [Ref. 5]. The mining of many metals and other minerals has been long established, coal, oil and gas are now extracted, and the existing pipeline system is being extended [Ref. 95]. The giant Lower

Figure 8-2:
The Soviet Arctic

Ob' Basin and to a lesser extent, the Pechora Basin, are sites of huge natural gas reserves [Ref. 5]. Rumors of a giant new Siberian oil field, containing seven times the world's current proven reserves, were circulating in late 1980, but these concerned a long established shale formation from which the Soviets have squeezed only marginal production. The U. S. Geological Survey believes an underground nuclear explosion in October 1979 was an attempt to stimulate oil flow [Ref. 125].

In spite of its position as one of the world's largest producers of hydrocarbon energy, the Soviet Union has been eager to develop arctic oil and gas reserves. The 1981-85 Five Year Plan includes record drilling increases, but these will not stem production declines which are the result of poorly planned, sluggishly executed programs in the 1970s. Western Siberia will have a leading role in new development, but exploration will also be conducted in Eastern Siberia and the Kara and Barents Seas [Ref. 133].

The Soviet push to explore and develop its more inaccessible reserves will be greatly hindered by a lack of technological sophistication. The lag, compared to state-of-the-art in the West, has been estimated at 15 years [Ref. 151]. As a result, there has been heavy reliance on imported technology. Three drillships are currently being constructed in Finland for use in the Kara and Barents Seas; the 490-foot vessels will be capable of drilling to 6000 meters in water

up to 300 meters deep. Delivery of the lead ship will be in 1981, with operations to start in 1983 [Ref. 134]. It has been noted that President Carter's trade embargo resulting from the invasion of Afghanistan has seriously affected the transfer of drillbit technology to the Soviet Union [Ref. 121]. How severely the recent cooling of U. S.-Soviet relations will delay production plans is not clear, but offshore drilling technology seems especially sensitive [Ref. 5].

One area of longstanding Soviet dominance is arctic marine transportation. Waterborne transport has been the key to utilization of far north resources, and designation of the 2800-kilometer Northern Sea Route (NSR) as a "national route" reflects a parallel security concern. Extending from Novaya Zemlya to the Bering Strait, the NSR is open about five months each year for a two-way flow of goods from towns on the coast and from inland river sites [Ref. 142]. More than half of the four million tons of cargo is timber from the Igarka and Noril'sk areas [Ref. 5]. The NSR's importance as a binding national link is great; it has been described as an alternative to the Trans-Siberian Railroad [Ref. 143].

There is also a darker side to the NSR's history. It was used extensively in the 1930s to transport prisoners to arctic labor camps. Solzhenitsyn has described an early season transit of several prison barges and the icebreaker KRASSIN in 1938 [Ref. 27].

Table 8-1: World Icebreaker Resources, 1980
[Reference 11]

Ship/Class	Displacement	LOA (ft)	Draft (ft)	# Aircraft	Horsepower	Year Commissioned	Built
Argentina (Navy)							
(New)	9,600	421	32	2	15,000s	ord Feb 79	Argentina (?)
Almirante Irizar	11,811	392	31	2	16,200s	78	Wartsila
Gen San Martin	5,301 fl	279	21	2	7,100s	54	W Germany
Canada (Coast Guard)							
Pierre Radisson	8,180 fl	322	23.5	1	13,600s	78	Canada
Franklin	" "	"	"	"	"	79	"
Louis St Laurent	13,800 fl	367	31	2	24,000s	69	"
Norman M Rogers	6,320 fl	295	20	1	12,000s	69	"
John Cabot	6,375 fl	313	21.5	1	9,000s	65	"
John A Macdonald	9,160 fl	315	28	2	15,000s	60	"
Labrador	6,490 fl	290	29	2	10,000s	54	"
D'Iberville	9,930 fl	310	30	1	10,800s	53	"
Japan (Maritime Defense Force)							
(New)	11,000	433	30.5	3	30,000s	82	Japan
Fuji (Antarctic research vessel)	8,566 fl	328	29	3	12,000b	65	"

Table 8-1: World Icebreaker Resources, 1980
(Continued)

USSR (Mostly Ministry of Merchant Marine; some naval, some KGB manned. Most vessels unarmed)								
(New)	?		?	?	?	80,000s		
(Still in design stage, 1974-79; nuclear)								
Arktika	24,460	fl	485	36	1	66,000s;n	75	
Sibir	"	"	"	"	"	"	77	
Lenin	19,240	fl	407	34.4	2	39,200s;n	59	USSR
(Accommodations for 1000)								
3-Yermak	20,241	fl	443	36	2	36,000s	74,75, 76	Wartsila
5-Moskva	15,360	fl	401	34.5	2	22,000s	60-69	"
2-Kapitan Sorokin	14,900		433	28	2	22,000s	77,78	"
2-(New)	15,000		433	28	2	22,000s	80,81	"
Otto Schmidt	3,650		?	?	?	5,400s	79	USSR
3-(New)	5,000		283	20	-	12,400s	82,83	Wartsila
Purga	3,000	fl	295	17	-	?	48	USSR
(KGB operated?)								
3-Kapitan Belusov	5,350	fl	273	23	-	10,500b	55,56, 57	Wartsila
20-Vasily Pronchish-tchev	2,675	fl	223	20	-	5,400s	61-65	USSR
5-Susanin	"		"	"	-	"	"	
(Armed; KGB operated)								
6-Kapitan Chechkin	2,240		255	11	-	4,490s	77-78	Wartsila
3-Kapitan Izmaylov	2,045		185	14	-	3,400s	76	"
5-Stroptivy	?		238	21	-	7,600s	79-80	"

Table 8-1: World Icebreaker Resources, 1980
(Continued)

Finland (Board of Navigation)							
2-Urho	9,500 fl	343	24	1	22,000s	75,76	Wartsila
3-Tarmo	4,890	281	22.5	1	12,000s	63,68, 70	"
3-Karhu	3,540	243	21	-	7,500b	58,59, 60	"
Voima	4,145	274	22.5	-	14,000s	54	"
Sweden (Navy)							
3-Atle (Urho class)	9,500 fl	343	24	1	22,000s	74,75, 77	Wartsila
Njord	5,686 fl	284	20	-	12,000s	69	"
Tor	5,290 fl	277	20.3	-	12,000s	64	"
Ale	1,488	151	16.4	-	4,750s	73	"
Thule	2,280 fl	187	19.4	-	4,800b	53	Sweden
Oden	5,220 fl	256	23	-	10,500s	58	"
Denmark (Ministry of Trade and Shipping)							
(New)	2,250	221	15.4	-	6,800s	?	Denmark
2-Danbjorn	3,685	252	20	-	10,500s	65,66	"
Elbjorn	1,400 fl	157	14.5	-	3,600b	66	"
United Kingdom (Royal Navy)							
Endurance	3,600	305	18	2	3,220s	56	Denmark
(Ice-strengthened ice patrol ship; British Antarctic Survey)							

Notes:
Manning organization is indicated for each country
Displacement in tons; fl = full load
Horsepower indicated is brake horsepower (b) = power at crankshaft, or shaft horsepower (s) = power delivered to shaft; n = nuclear
Wartsila is the Finnish shipyard which is noted for its leadership in icebreaker construction

The Soviet Union maintains the world's largest icebreaker fleet, as shown in Table 8-1; not all are employed in the arctic since there are extensive icebreaking requirements in the Baltic, Caspian and Black Seas, in the Soviet Far East, and on inland rivers. Almost half of the fleet was built in Finland's Wartsila Shipyard, which is the centerpoint of world icebreaker technology. The Soviets have, in addition, numerous ice-capable cargo vessels, organized in six classes of ice worthiness. The 1977 register listed 257 ships in the "UL" and "ULA" classes, which are permitted to navigate independently as well as astern of icebreakers [Ref. 146]. There is reportedly a new generation of icebreakers and ice-strengthened ships under study [Ref. 142].

In August 1977 the nuclear-powered ARKTIKA became the first surface ship to reach the North Pole. Credit for this accomplishment must rest chiefly on ice reconnaissance which revealed a huge polynya, or open water lead in the ice [Ref. 29]. In May and June of the following year, SIBIR and an accompanying freighter transited from Murmansk to the Chukchi Sea, utilizing a high arctic route that touched the 83rd parallel [Ref. 29]. The intention behind these exploits is not clear. They have no relevance to Northern Siberian transportation; experimentation with commercial transportation in an international context has been suggested [Ref. 142].

Long term Soviet goals for the NSR probably include year-round navigation for this thoroughfare. Good progress has been made in the western areas, but more icebreakers, cargo vessels and navigational systems have been cited as requirements for extending the season on the remainder of the route [Ref. 143]. This objective may be a difficult one. Interestingly, since the 1940s summers (defined as periods with positive air temperatures) have decreased by one month in the Soviet arctic, and the mean annual air temperatures over the Kara Sea has fallen by three degrees Centigrade [Refs. 5, 142]. Advances in technology and technique may be merely offsetting a deterioration in climate [Ref. 142].

C. DEFENSE ISSUES

The degree of Soviet arctic orientation and involvement inevitably affects the international defense picture. Technological advances have, as previously mentioned, reduced the arctic's "barrier" role which historically has guarded rather than threatened the owner nations [Ref. 84]. The region's centrality is coming increasingly into focus.

In conjunction with the push of technology is the emergence of development activities, particularly the energy-related ones, which demand a closer look at arctic defense. Alaska's principal contribution to the national defense has heretofore been as a forward positon, providing early warning capability. The area is now intrinsically valuable; national

security may in the future hinge largely on energy independence and Alaska's oil and gas production would become doubly priceless in a conventional conflict. As it now stands, these facilities are extremely vulnerable to attack, and large tank vessels would make spectacularly attractive targets. Moreover, the U.S.-Canadian arctic is very lightly defended. In Alaska, there is a special-duty army brigade and a squadron of fighter aircraft. The Canadian arctic boasts a fine network of airfields but no combat aircraft, significant ground troops, warships or missile installations [Ref. 84]. Neither American nor Canadian icebreakers carry any significant armament.

The Soviet threat is considerably more formidable. There are at least seven Soviet airborne divisions, several special reconnaissance and sabotage brigades, four brigades of naval infantry and large numbers of arctic-trained troops. Soviet planning includes use of so-called "Desant" operations, or air and sea landings to capture or destroy military bases in enemy territory. Potential targets also include pipelines, oil field installations, weather stations and police posts. Familiarization with climate and terrain will give the Soviets an added edge in arctic operations [Ref. 84]. As development in arctic Alaska proceeds, the number of militarily suitable targets will increase.

Another "militarizing" threat to the arctic stems from missile-firing submarines. The Soviets are building a new

class of very large submarines (18,000 tons, dived) [Ref. 11]. Since Soviet coastal areas are isolated from the world's principal oceans, these new strategic submarines could conceivably be based in the Murmansk area and deployed in the Arctic Ocean to avoid transiting the well-patrolled Greenland-Iceland-United Kingdom "gap." Such a strategy is not without drawbacks, particulary with respect to communications.

In evaluating an arctic wartime scenario, the importance of naval forces and surface shipping, apart from possible sub-arctic mine-laying and anti-submarine warfare, will be negligible [Ref. 84]. These forces would be easily detected and destroyed in an all-out conflict [Ref. 70]. Troops would undoubtedly be employed in small numbers to defend or secure the scattering of strategically valuable points. In this regard, large transport aircraft can be viewed as the key to arctic military operations [Ref. 84]. Such a scenario contrasts with the early days of World War II, when surreptitious German weather stations were established in Greenland and had to be laboriously taken by landing parties from ships. Coast Guard cutters were centrally involved in these operations [Ref. 1].

Recent world events have demonstrated that a fully integrated defense must plan for more than the threat of conventional military forces. Terrorist operations will undoubtedly continue as a means of accomplishing certain

political objectives. The Alaska Pipeline has been the target of more than one amateurish though damaging attempt at sabotage, and military and FBI studies have concluded that little can be done to effectively secure it [Ref. 4]. With the expansion of the development facilities, the increased risk of serious terrorist damage is not encouraging.

A final related issue involves the harrassment of peaceful undertakings in the arctic. The case in point is the shadowing of the Norwegian vessel POLARSIRKEL by a Soviet icebreaker during research operations near northeastern Greenland in 1979 [Ref. 175]. Such activity is no more acceptable in the arctic than on high seas elsewhere.

The superpowers face each other across the Arctic Ocean, and the confrontation is no longer merely in an East-West setting. As one author predicts, "In the future, this region could become the center of the West's military position, with the Orient and Europe on the wings, geographically and perhaps even politically" [Ref. 84]. American policy will be under increasing pressure to acknowledge this possibility.

D. TOWARD A UNITED STATES ARCTIC POLICY

Inspite of arctic Alaska's growing importance since the 1968 oil announcement, there is no clearly stated U.S. policy regarding the arctic [Ref. 164]. Neither is there a "managing agency" as an Office of Management and the Budget

circular designated the National Science Foundation for the U.S. antarctic program [Ref. 37]. It would be incorrect to state that the highest levels of the federal government are oblivious to changes in the arctic; instead, interests and responsibilities for the multi-faceted region are splintered among a large numger of cognizant agencies and lack an integrated focus. The situation is in some regards analogous to that in Canada.

A significant step toward formulation of an arctic policy came with creation of the Inter-Agency Policy Group (IAPG). This high-level council was established on November 8, 1979 by National Security Council Director Zbigniew Brzezinski; the driving force was the initiative of Thomas Pickering, Assistant Secretary of State for Oceans and International Environmental and Scientific Afairs (OES). The IAPG absorbed the activities of a previously dormant National Security Council responsibility [Ref. 167].

IAPG membership includes [Ref. 167]:

--Assistant Secretary of State (OES) as chairman.

--Department of Transportation, represented by the Commandant of the Coast Guard; his alternate is the Chief, Office of Operations.

--National Atmospheric and Oceanographic Administration.

--Department of Energy.

--National Aeronautics and Space Administration.

--Department of the Interior.

--Environmental Protection Agency.

--U. S. Navy.

--Office of Science and Technology Policy.

--Council for Environmental Quality.

--Central Intelligence Agency.

--U. S. Arms Control and Disarmament Agency.

--Federal Aviation Administration.

--U. S. Air Force.

The group has produced a number of working papers on various arctic issues [Ref. 167], and a study to determine methods of speeding hydrocarbon removal is underway [Ref. 164]. However, there has been little visible evidence of shifts in policy.

The incumbent Commandant of the Coast Guard, Admiral John B. Hayes, has indicated especial interest in the arctic, due in part perhaps to his previous assignment as Commander of the Seventeenth District which is comprised of the entire state of Alaska. The Coast Guard is seeking development and promulgation of an arctic policy through its membership in the IAPG [Ref. 164].

Although less directly oriented toward arctic policy, the National Petroleum Council is studying certain issues as a joint government-industry project. The Committee on arctic oil and gas resources was tasked by Energy Secretary Duncan to undertake a comprehensive review of the hydrocarbon energy situation in the region. In addition to formulating a composite estimate of resources in place [Ref. 169],

transportation requirments through 2000 will be indentified [Ref. 164]. The Marine Science and Icebreaking Division chief from Coast Guard headquarters is a member of the committee.

It remains to be seen whether a comprehensive arctic policy will emerge at the federal level, particularly with a recent change of administrations. However, the following occurrences seem likely:

--the sovereignty issue will be debated in principle, and work toward defining the legal status of the arctic will continue under the auspices of the Law of the Sea Conference. Sovereignty issues will most directly affect the United States, however, by institution of foreign-flag tanker traffic. Concern over the threat to Alaska's coastal waters will undoubtedly result in bilateral negotiations and stringent operational regulations.

--as oil and gas development expands, there will be increasing awareness of the vulnerability of these facilities as military targets, and of the importance of arctic energy to the national security. However, there will probably be little material response to this awareness due, in part, to the urgency of more traditional defense needs; the impossibility of completely securing the facilites will also be a barrier to incremental expansion of Alaskan defense resources. Awareness of military sensitivity may be incorporated in planning and in arctic training for units based in the "lower 48." This is now occuring on a limited basis.

--securing of energy facilities against sabotage or terrorist damage may be more readily dealt with. Government-industry cooperation in this area seems likely. In addition, protection of legitimate arctic activity from foreign interference could become a concern.

--taking cognizance of the arctic's importance to defense, Canada may, within the context of the North Atlantic Alliance, attempt to shift more of its defense posture to the arctic and away from central Europe. This would be closer to direct Canadian interests and even desirable for NATO. The small Canadian military forces might be more effectively useful on home ground, securing the arctic "central front."

--Soviet arctic development will, unlike events in the Canadian arctic, exert little direct influence on the future of arctic Alaska. This is due to the Soviet technology lag, and to the greatly differing geographic, social and political settings in the Soviet Union and Alaska.

IX. COAST GUARD ICEBREAKING, ARCTIC ALASKA AND THE FUTURE

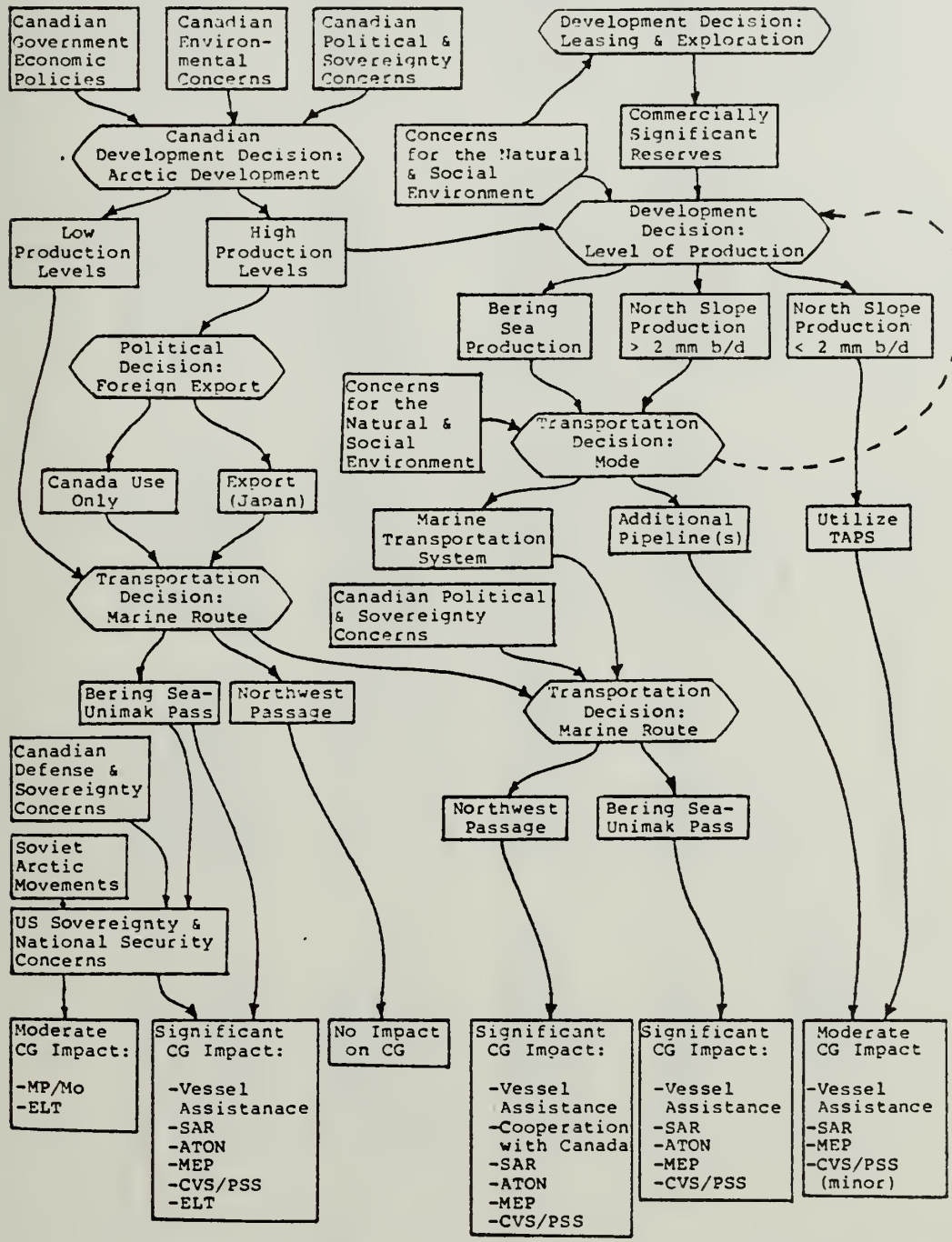
A. SYNTHESIS

The preceeding five chapters have attempted to examine, separately and in detail, each of five issues which were selected as relevant indicators of the future in arctic Alaska. As was previously mentioned in Chapter III, the benefit of such an approach is the closer and clearer focus that is allowed by "specialized" examination; the risk is that of losing an overall perspective. The purpose of this chapter is twofold: to "reconnect" the five issues into a comprehensible view of of probable events extending to the end of the century, and to draw from this a likely impact on Coast Guard icebreaking needs.

Figure 9-1 models a process of relationships between various facets of the five issues. The matrix in Figure 9-2 describes the manner in which they relate to each other most significantly.

The process in Figure 9-1 centers around two development decisions and two transportation decisions which will determine the future in arctic Alaska, and three slightly differing decisions in Canada. Factors which directly influence these decisions and the results which stem from them are shown. The outcome of one decision often becomes

Figure 9-1: A Process of Impacts on Icebreaking in Arctic Alaska



The effect of ↓ on →	Energy Development	Energy-Related Transportation	Environmental Concerns	Canadian Arctic Developments	International Concerns: Defense & Sovereignty
Energy Development	**********	Significant Effect Pace and location of energy development will determine transportation systems.	Negligible Effect The prospect of energy development may arouse some environmental concern.	Negligible Effect US arctic efforts lag Canadian events now in progress.	Moderate Effect Protection of facilities.
Energy-Related Transportation	Moderate Effect Feasibility of transportation systems or presence of existing systems will augment development attractiveness.	**********	Negligible Effect The prospect of arctic transportation may arouse environmental concern.	Negligible Effect US arctic transportation efforts lag Canadian projects.	Moderate Effect Protection of vessels or pipelines.
Environmental Concern	Significant Effect Modifying influenc --ensuring safeguard and preservation of special areas.	Significant Effect Modifying influence --ensuring safeguards and preservation of special areas.	**********	Negligible Effect Some concern over global effects of Canadian actions may be expressed.	Negligible Effect Some concern over global effects of Canadian actions may be expressed.
Canadian Arctic Developments	Significant Effect Technological leadership in arctic development.	Significant Effect Technological leadership in arctic development.	Negligible Effect Some concerns over global effects of Canadian actions may be expressed.	**********	Significant Effect Canadian and other foreign tanker transits through Alaskan waters.
International Concerns: Defense and Sovereignty	Moderate Effect "Energy independence as a motivation for development of arctic resources.	Negligible Effect	Negligible Effect	Negligible Effect	**********

Figure 9-2: Arctic Issue Relationships

significant input into another. The eventual "fallout" from this process are likely impacts on the icebreaking program.

The central decisions involve development of the hydrocarbon resources and transportation of the products. As the concluding lines of Chapter IV indicated, energy development will be, with little doubt, the driving force behind events in arctic Alaska for the forseeable future. Further, it was stated in Chapter III that waterborne transportation, as one of the Coast Guard's core concerns, would perhaps be the most significant channel for energy activity to affect the icebreaking mission. Figure 9-1 demonstrates this flow.

A number of possible event combinations (though by no means all of them) are shown in the figure. In the near-term, for example, accelerated leasing and exploration will in all probability uncover significant new reserves on the North Slope. But as discussed in Chapter IV, it is unlikely that this will push total North Slope daily production over the two million barrel level. Thus TAPS will continue to be the sole mode of transportation, and the impact on the Coast Guard will be moderate.

In a slightly longer range context (c. 1995: see Figure 4-3), however, Bering Sea production will necessitate choice between a marine transportation system and additional pipeline construction. With the small likelihood of the latter alternative, a marine route must be chosen, and the Bering Sea-Unimak Pass circuit seems most favorable. The

transportation choices are discussed in Chapter V. It was also noted that an installed transportation system will have a reinforcing effect on the decision to develop contiguous areas.

Influencing U. S. decision points will be concerns for existing natural and social environmental systems, the subject of Chapter VI. The rate of leasing and exploration, the level of production, and the mode of transportation for extracted oil and gas will be affected. Canadian arctic events will also be a source of influence. A move toward high arctic production levels, which appears to be underway in Canada, will affect Alaskan production; as Chapter VII points out, this will be chiefly through the "pull" of new technology and technique. Canadian sovereignty concerns will similarly be a factor in route selection for a marine transportation system.

Should Canada make the political decision to export its arctic resources, or to use a western sea corridor for transportation to domestic markets, a direct impact on American sovereignty and national security concerns will result. Soviet moves in the arctic and changes in Canada's defense posture will be parallel influences, as discussed in Chapter VIII.

Two qualifications of Figure 9-1 are in order. First, it should be noted that the decisions shown are not simple executive choices; in most cases neither are they solely

political choices. They represent instead broad questions which must be resolved by all segments of society. The decision on level of production, for example, will be made as a synthesis of input from industry, local residents, the environmental lobbies, and governmental entities. This leads directly to the second point: the figure represents a simplification of reality and a set of only the most plausible relationships. The inclusion of all possible combinations of events is not practically possible. Limited though the method may be, it is possible to surmise potential impacts on the need for public icebreaker support.

B. IMPACTS ON THE ICEBREAKING PROGRAM

However the future unfolds, icebreaking ships seem assured of having a role in polar marine transportation. Cost-benefit analysis of icebreaker-assisted cargo carrying supports this argument [Ref. 37], and few other alternatives can match the multi-faceted capability and endurance of an icebreaker.

Figure 1-3 provides a conceptual framework of polar icebreaking functions, viewed primarily as servicing the needs of user organizations. Certain Coast Guard-generated requirements are also involved. For application to the circumstances in the western arctic, the elements of Figure 1-3 can be distilled into three broad, functional areas:

--scientific research support.

--assistance to vessels.

--support of other Coast Guard operating programs, or requirements generated by the Coast Guard itself. Current Alaskan icebreaking involves all of these, but demands of the future will not touch them equally.

The largest growth will probably emanate from the latter two functions: there will be expanding demand for traditional vessel assistance, along with dramatic increases in the arctic requirements of other Coast Guard operating programs. Research will remain, but as an essentially static or "low growth" activity. Interest in scientific inquiry will undoubtedly be enhanced by arctic development; however, as an indirect resultant of processes in motion, it will be shouldered aside by more pressing needs.

As Figure 9-1 indicates, requirements for assistance to commercial vessels will result from several pathways in the diagram. Whatever the degree of energy development in arctic Alaska, movement of materials by tug and barge will be an integral factor. As was the case in the development of Prudhoe Bay, this will necessitate at least occasional icebreaker support. The impact becomes more significant if a product carrying marine system develops. Icebreaking tankers from the North Slope or Chukchi Sea, however powerful, will require at least standby icebreaking capability, and less ice-worthy Bering Sea shipping perhaps to a greater extent.

Shipment of arctic Alaskan oil or gas through the Northwest Passage will entail not only icebreaking support in American waters but undoubtedly a sharing of responsibility for Canadian waterways as well [Ref. 37]. (This adds one more complicating feature to the Northwest Passage alternative). Finally, vessel assistance would be involved in foreign ship transits of arctic Alaskan waterways, if only for emergency purposes.

Determination of the level of icebreaker support to be provided will be a difficult policy issue for the Coast Guard to resolve. For movement of development materials, the industry would without doubt desire a wide range of available resources, instantaneous response, and a shipping season of maximuum length. Against these demands must be matched a finite number of icebreaking resources, and a balance struck with other requirements in the western arctic and in other parts of the world. The precedent for Coast Guard icebreaker assistance exists in the Prudhoe Bay convoy operations, but providing support for large scale marine operations could be seen as a responsibility to be partially shared by industry. Reimbursement for icebreaker service is one possibility. It is even conceivable that the multinational oil industry would move to develop its own support ships rather than depend on the exigencies of the budgetary process. Canada's Dome Petroleum appears to have taken steps in this direction (see Chapter VII).

Nonetheless, it seems clear that support of energy-related arctic transportation will be viewed by the Coast Guard as a central responsibility; this position will arise from the strong transportation focus of the entire service, from the traditional vessel assistance aspect of icebreaking in particular, and from the high national priority placed on petroleum availability [Refs. 37, 164]. It is perhaps unnecessary to add that providing substantial icebreaker support will require additional resources.

The second principal source of requirements will result from the other Coast Guard operating programs, and these expanded programmatic needs will similarly arise from events now in motion. Icebreakers will to a significant degree provide the capability for prosecuting these program responsibilities in a unique and demanding environment. This will represent a further affirmation of the multi-program status of Coast Guard operating units. Many of the potential program requirements involve elements of a transportation support system, mentioned in Chapter V. Potential program requirements include:

--search and rescue (SAR): since the arctic will at least initially be devoid of other SAR facilities, icebreakers will be the prime units for assisting personnel and property in ice-covered waters. Response will be enhanced by helicopters carried onboard. There will obviously be a fine distinction between SAR and vessel assistance, e. g. the point at which a ship beset in the ice becomes endangered. Workboats used to service offshore installations constitute a large SAR potential. Overall, SAR will not be a new requirement: from 1974 to 1979, Coast Guard icebreakers responded to 17 calls for assistance in the Alaskan arctic [Ref. 161].

--aids to navigation (ATON): while icebreakers will not in all likelihood assume full responsibility for a system of arctic marine aids, they will undoubtedly be called upon to restore outages and to service aids unreachable by other means. Again, helicopter capability will be a decided asset.

--marine environmental protection (MEP): icebreakers will provide a surface and air surveillance capability, and perhaps more importantly, act as platforms for monitoring and conducting cleanup efforts almost year-round. Recent Coast Guard planning for an arctic pollution response system involves icebreaker logistic support [Ref. 166].

--commercial vessel safety (CVS) and port safety and security (PSS): vessels and terminals in the arctic will be subject to existing and possibly special regulations administered through these programs. A seaward support capability for port emergencies will also be desirable. In addition, the Coast Guard has statutory responsibility for structures such as drilling rigs on the outer continental shelf [Ref. 2]. Icebreakers will serve as platforms for conducting inspections and investigations.

--enforcement of laws and treaties (ELT): icebreaker presence will represent the primary means of asserting U. S. sovereignty over its arctic waters, and protecting national interests in the area. As discussed in Chapter VIII, ensuring adherence to environmental regulations will be a central concern; the increase in fishing activity near the Bering Sea ice edge represents another [Refs. 48, 166].

--military preparedness and operations (MP/MO): this is is perhaps the most contingent of the program areas. Icebreakers will be available to support military and naval operations in the arctic, and would undoubtedly participate in defense or security exercises resulting from increased defense emphasis in the region. Icebreakers, with their substantial fuel and stores capacity, have been suggested as tenders for patrol boats, although presumably not in polar environments [Ref. 77]. Icebreakers would probably be irrelevant in an all-out conflict; but arctic shipping would be significantly valuable in a limited war or prior to open hostilities [Ref. 70]. Protection of research and commercial activities from low-level harrassment may be a new facet of the icebreaker's military role. Concern for matching icebreaker capability with the Soviet Union and Canada has been voiced [Refs. 48, 161]. Whatever their exact role, heightened defense or security concerns will involve icebreaker participation.

The bottom of Figure 9-1 indicates the operating programs affected by each flow of events.

With the marine science (MSA) program continuing as a research activity, icebreaking requirements in arctic Alaska will encompass all operating programs except boating safety and bridge administration. The likely unfolding of events thus respresent an extremely broad-based effect on the entire Coast Guard. They will be manifested through requirements for the icebreaker fleet.

C. ICEBREAKER REQUIREMENTS

The initial sections of this chapter attempted (1) to combine the detailed reviews of five issue areas into a general outline of future events in arctic Alaska, and (2) to examine the impacts of this stream of events on Coast Guard icebreaking. The final step is to translate these impacts into specific hardware needs. This is probably the most difficult, and easily questioned, undertaking in this paper.

The approach here is not that of a comprehensive quantitative study, but rather an evaluation of previous studies and of current efforts to match icebreaking resources to needs.

A Coast Guard study completed in 1975 [Ref. 42] omitted potential growth of Alaskan marine commerce in its examination of icebreaking and icebreaker requirements, because this factor was considered too speculative. Nonetheless, while

existing resources were deemed adequate to meet 1978-85 demand, the study predicted need for an additional western arctic icebreaker after this period. The potential development of resources in arctic Alaska was only noted.

Long term requirements were more thoroughly examined in a 1979 Coast Guard study [Ref. 37]. The impact of energy development in and around Alaska was very heavily emphasized, and preliminary findings of the Coast Guard-sponsored Energy Resources Company-E. G. Frankel (ERCO/EGF) study were used extensively. The 1979 study concluded that:

--to meet "baseline" or current requirements only, a fleet of five to six icebreakers will be needed through 2000.

--although the present fleet includes five icebreakers, currently known requirements cannot be met with the existing mix of ships.

--"aggressive pursuit" of polar energy resources will gen- erate a requirement for approximately nine additional icebreakers.

This particular analysis points to two deficiencies: the lack of a proper mix in the icebreaker fleet, and the need for additional ships to meet upcoming demands. For operations in arctic Alaska, imbalance in fleet mix can be translated as lack of a shallow draft capability. This has been recognized as a problem for some time, and was particularly highlighted by attempts to assist Prudhoe Bay tug and barge convoys in the 1970s. As Table 1-1 illustrates, there is no icebreaking capability between the deep draft larger ships and the severely underpowered STORIS.

The ERCO/EGF study recognized this need and recommended procurement of two to four shallow draft icebreakers ("SDIB") depending on the development scenario, in the period 1979 to 1995. These ships would have the ability to break 2.5 to 3.0 feet of ice, be helicopter capable, and possess armament and equipment necessary to support a number of program requirements. Basing the vessels in Dutch Harbor and Kodiak to achieve more availability was also recommended [Ref. 48].

In a 1979 letter, the Commander of the Seventeenth Coast Guard District (encompassing all of Alaska and its waters) also voiced the need for development of a SDIB. The reasons for procurement were felt to be

> . . . more a matter of policy than of specific, quantifiable needs at the present time. Opportunities for ice assistance will certainly increase in the future, but at a rate that is difficult to predict. I do believe that we must keep pace with commercial development in arctic and sub-arctic Alaska. We do not need to build a shallow-draft icebreaker solely to "support" commercial development in these areas, but rather, to meet the search and rescue, enforcement of laws and treaties, emergency escort services, defense and scientific research, and marine environmental protection requirements associated with the expansion of maritime commerce into ice covered waters [Ref. 161].

The Coast Guard headquarters staff has begun the process of procuring shallow draft capability with preparation of a "Mission Needs Statement" in late 1980. This document defines the necessity for acquiring a major system without detailing a specific means for accomplishing it. The statement outlines a shallow draft requirement by 1990-91, and related the need to other program requirements as well as

to vessel assistance [Ref. 163]. The time frame is in consonance with the ten year lead time for new ships, mentioned in Chapter III.

Other attempts to fill the shallow draft gap involve the budgetary request for re-engining STORIS noted in Chapter I, and a proposal to refit one or more of the ice-strengthened buoy tenders. These would be purely interim measures, adding only marginal capability to ships already approaching the limits of their useful lives. They would, however, provide some response to icebreaking demands that will undoubtedly come from increased North Slope barge traffic in the middle of this decade.

The acquisition of two (or more) SDIB will supplement the icebreaker fleet in numbers as well as in its mix. The POLAR-class ships will remain in service at least until the end of the century; GLACIER will probably be decommissioned by 1991 [Ref. 37] and one SDIB will be merely a replacement. It should be noted, however, that supposedly worn out Coast Guard icebreakers tend to outlive their planned decommissionings by several years.

With these considerations, the outlook to 2000 takes the following shape:

--GLACIER and the POLAR-class vessels are available to carry out current icebreaking requirements, and some additional ones, throughout the 1980s.

--a more powerful STORIS and possibly some reconditioned buoy tenders are available for the increase in barge tonnage in the mid 1980s. They are also able to support other

program requirements during summers and in less demanding ice conditions.

--a shallow draft icebreaker becomes operational by 1991, replacing GLACIER in western arctic deployments. The SDIB does not have the endurance, however, to replace GLACIER's role in the antarctic. This fact means a reduction in POLAR-class arctic availability if antarctic demands remain constant.

--a second and possibly more SDIB follow. These ships are homeported in Alaska because of their primary dedication to the area.

--as a marine transportation system emerges in the mid 1990s, the POLAR-class icebreakers assume the additional role of assisting the cargo vessels when circumstances dictate.

--in extraordinary or emergency conditions, the east coast based NORTHWIND and WESTWIND (and their eventual replacements) are available for deployment to arctic Alaska. Use of this "reserve" force would be inefficient, costly and would detract from icebreaking requirements elsewhere.

In its entirety, this outlook seems to present a reasonable response to the demands of growth in arctic Alaska. One factor not accounted for would be a possible need for one or more new deep draft icebreakers following GLACIER's decommissioning; the demands of assisting arctic tank vessels, fulfilling antarctic requirements and meeting the various program needs will in all likelihood exceed the capacity of the two POLAR-class ships.

Several contingencies may require change to the above schedule. These include:

--a speed-up in the general pace of arctic development, generating earlier and a larger volume of logistic traffic.

--earlier implementation of a marine transportation system.

--adoption of a Northwest Passage route for transporting energy cargoes.

--large changes in the arctic's defense status.

The outlook presented above is most likely a conservative view. Exogenous events may speed the timetable, but given the energy imperatives of the next twenty years, it is doubtful that Alaska's oil and gas potential will be allowed to lie dormant. As was stated in Chapter III, the events that could change the energy situation overnight tend to be outside the realm of logical forecasting.

The Coast Guard will participate meaningfully in the emerging future of arctic Alaska, but will be principally in the position of having to meet demands for its services. The problem for the Coast Guard, simplistically stated, is the necessity to react to events years in advance of their actual occurrence, while recognizing that obtaining the resources for adequate response is largely a function of an unpredictable budgetary process. It is a process the Coast Guard can prepare for and possibly influence, but not control. The future icebreaker fleet is ultimately decided in this political arena, in competition with a myriad of other programs and priorities.

The Coast Guard must, as the custodian and operator of the nation's icebreakers, also play an advocate role for this program. Much of the budgetary influence comes from rational and coherent examination of the future and its demands. It

provides the informational "ammunition" that will be needed to ensure fulfillment of historic and statutory responsibilities. The Coast Guard's icebreaking role in arctic Alaska thus depends heavily on how it assesses the world yet to be.

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